COMMERCIALLY IMPORTANT COPPER ALLOYS

CHASE

The Commercially Important WROUGHT COPPER ALLOYS

CHASE BRASS & COPPER CO.

— Incorporated —

Subsidiary of Kennecott Copper Corporation

WATERBURY CONNECTICUT

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THE COMMERCIALLY IMPORTANT WROUGHT COPPER ALLOYS

CHASE

INTRODUCTION

There are presented herewith lists of the more common and useful wrought copper alloys sold by the Chase Brass & Copper Co. They are to be preferred to various slight modifications which can be and are made, but which are not standard mill alloys and seldom offer real advantage. For each alloy there is shown the name most commonly used together with other names sometimes applied. We also give the nominal composition of the alloy, the forms in which it is available, physical properties for a variety of tempers, and typical uses.

Physical property data, such as tensile strength, elongation, and hardness, are given for a sufficient number of tempers to demonstrate the range of properties, but in most cases alloys can be furnished in other tempers in addition to those indicated. **It should be remembered that average values are given in all cases and that a reasonable variation must be expected commercially. They must not be used for specifications.**

In the text and tables frequent reference is made to the capacity of the various alloys for being worked, machined, or welded. It must be realized that data of this kind must of necessity be approximate only. The ratings given therefore should be considered as first approximations and should serve merely to determine whether or not a given alloy be considered for any contemplated use.

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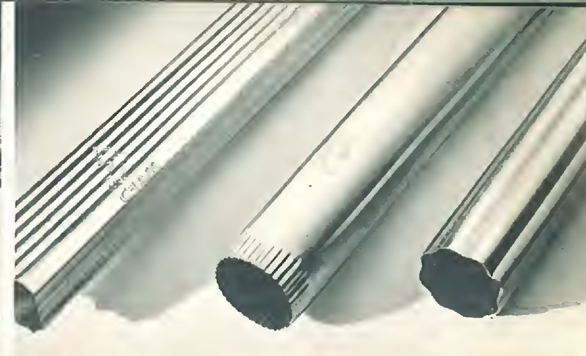


COPPERS BY CHASE

Electrolytic Tough Pitch Copper is still used in much greater quantity than all others combined and is likely to continue so. The conductivity of this copper is very high and the general working and physical properties excellent. However, it has a serious disadvantage for certain applications; namely, the susceptibility to embrittlement when heated at elevated temperatures in a reducing atmosphere. Also for certain work requiring a high finish this copper is objectionable on account of surface markings due to the contained oxide.

Oxygen free coppers and high conductivity phosphorus deoxidized copper (containing a very low residual phosphorus content) are to all intents and purposes the same. Both have high conductivity and immunity to embrittlement.

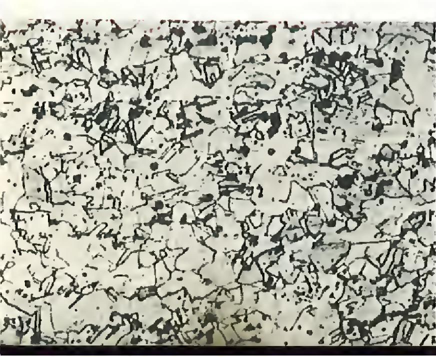
Ordinary phosphorized copper contains a relatively greater residual phosphorus content and is therefore of low conductivity. In all other respects it is equal or superior to any of the high conductivity coppers.

Arsenical Copper may be either a natural product, resulting from the use of arsenic-bearing ores or an alloy made from copper and metallic arsenic. Arsenical Copper may be obtained with arsenic content up to at least 0.5%, the most common amount for commercial material being about 0.25%.

All types of copper in common with the alloys of copper are highly resistant to most corrosive media. Although the degree of resistance of the alloys varies markedly, the several types of copper listed in this section show closely the same high resistance.

The forms in which these types of copper are available together with suggested uses, physical and mechanical properties, etc., are shown on the following pages.

CHASE



Left: Annealed Tough Pitch Copper. Magnification 100 X. (Black dots are cuprous oxide particles.)

Right: Annealed High Conductivity Phosphorized Copper. Magnification 100 X.

FORMS AND USES

ELECTROLYTIC TOUGH PITCH COPPER

Forms Available: Sheet, Strip, Tube, Rod, and Wire

Suggested Uses: Electrical conductors, roofing, downspouts and gutters, flashings, building fronts, radiator cores, marine work, screen wire, screen cloth, radiators, rivets, nails, tacks, cotter pins, burs, soldering irons, conductivity wire, bus bars, ball floats, gaskets, projectile rotating bands.

OXYGEN-FREE COPPER

Forms Available: Sheet, Strip, and Tube

Suggested Uses: Electrical conductors, water tubing, heater units, distiller tubes, gasoline supply, refrigerator tubing, radiators, condenser tubes, oil coolers.

HIGH CONDUCTIVITY PHOSPHORIZED COPPER (Approx. 0.007% P)

Forms Available: Tube

Suggested Uses: Electrical conductors, water tubing, heater units, distiller tubes, gasoline supply, refrigerator tubing, condenser tubes, oil coolers, oil burner tubes, dairy tubes.

LOW CONDUCTIVITY PHOSPHORIZED COPPER (Approx. 0.02% P)

Forms Available: Sheet, Strip, and Tube

Suggested Uses: Water tubing, heater units, distiller tubes, gasoline supply, refrigerator tubing, radiators, rivets, spinning, drawing, forming, condenser tubes, oil coolers, oil burner tubes, dairy tubes, projectile rotating bands.

ARSENICAL COPPER

Forms Available: Tube

Suggested Uses: Heat exchanger tubes, condenser tubes, boiler tubes.

(Fabrication) PROPERTIES

Name	Approximate Relative Suitability for being worked		Best Temperature for Hot Working Deg. F	Approximate Relative Suitability for Being Welded				Approximate Relative Machinability (Free Cutting Brass = 100)
	Cold	Hot		Gas	Carbon Arc	Metallic Arc	Resistance	
Electrolytic Tough Pitch Copper	Excellent	Excellent	1400-1600	Poor	Fair	Good	Poor	20
Oxygen-Free Copper	Excellent	Excellent	1400-1600	Fair	Good	Good	Poor	20
High Conductivity Phosphorized Copper	Excellent	Excellent	1400-1600	Fair	Good	Good	Poor	20
Low Conductivity Phosphorized Copper	Excellent	Excellent	1400-1600	Fair	Good	Good	Poor	20
Arsenical Copper	Excellent	Excellent	1400-1600	Fair	Good	Good	Fair	20

(Physical)

Name	Density Lbs. per Cu. Inch	Melting Point Deg. F	Coefficient of Thermal Expansion Average 25 C to 300°C X 10-6	Electrical Conductivity % I A C S	Thermal Conductivity Cal./sq. cm./cm./Sec./deg. C at 20 deg. C
Electrolytic Tough Pitch Copper	0.323	1980	17.7	101	0.92
Oxygen-Free Copper	0.323	1980	17.7	101	0.92
High Conductivity Phosphorized Copper	0.323	1980	17.7	101	0.92
Low Conductivity Phosphorized Copper	0.323	1980	17.7	80-90	0.75-0.85
Arsenical Copper	0.323	1980	17.7	45-80	0.42-0.75

Hardness and Tensile Properties of the Five Types of Copper

Temper	Rockwell "F" Hardness	Tensile Strength p.s.i.	Elongation in 2" percent
0.040" Sheet—0.015 mm Anneal	45	35,000	45
0.040" Sheet—0.030 mm Anneal	40	32,000	45
0.040" Sheet—Hard	90	51,000	10
0.040" Sheet—Spring	95	57,000	6
1" x 0.049" Tube—0.030 mm Anneal	—	32,000	45
1" x 0.049" Tube—Hard	—	50,000	12
# 12 B&S Wire (0.081") 0.030 mm Anneal	—	32,000	—
# 12 B&S Wire—Hard	—	60,000	—

NOTE: The above figures are average and not to be used for specification purposes.



BRASSES By CHASE

The copper-zinc alloys, known as the brasses, form one of the most useful groups of alloys known to industry. They are characterized by ease of working, ductility, malleability, good strength, excellent corrosion resistance, pleasing color, and other desirable properties.

The useful wrought alloys of the straight copper-zinc series cover a wide range of composition, the copper content extending from about 58% to 100%. The range of properties is correspondingly great, making them suitable for a variety of uses.

WORKING

All the alloys may be cold worked, those with over 62% copper to a very considerable degree. Alloys with copper contents from about 58% to 63% and those containing from about 85% to 100% of copper may be extensively hot worked. Those containing from about 70% to 85% can be hot worked less extensively and those containing from about 63% to 70% copper with difficulty. Strength, in general, for a given treatment increases as copper content decreases.

ANNEALING

The temperature used for annealing the brasses will depend on the properties desired and the use to which the material is to be put. The actual metal temperature will vary from about 750°F to 1200°F for the lower copper content alloys and from about 800°F to 1150°F for the higher copper alloys. With a copper content less than about 65% only slow cooling

Left: Annealed Muntz Metal. Magnification 100 X. (Twinned grains in background are alpha; elongated grains are beta.)

Right: Annealed High Brass. Magnification 100 X.

should be used so as to preclude the retention of an excessive proportion of the relatively hard Beta constituent. The rest of the alloys may be cooled slowly or rapidly without effect on the quality or properties. Where annealing during fabrication is necessary, and accurate temperature control is not available, it is better to use brass of at least 68% copper.

COLOR

The color is pleasing in all cases. Small percentages of zinc have practically no effect on the red color of copper, but with the addi-

Extra Hard Temper Strip High Brass. Magnification 100 X.

tion of 10% of zinc a bronze color is obtained. With 15% of zinc a golden color is produced, the alloy often being used for inexpensive jewelry. At 20% zinc but a slight reddish color remains. With increasing amounts of zinc, the color further changes so that between 25% and 38% we have the typical yellow brass color. With more than 38% zinc the alloys take on a reddish cast.

CORROSION RESISTANCE

The widespread use of the brasses is to a great extent due to their resistance to corrosion, which is a subject so complex as to be impractical of exposition in a limited space and in concise tabular form. The resistance of any one alloy varies markedly with different conditions of exposure. In general, however, the resistance of Muntz Metal to most aqueous solutions is relatively poor. Increasing the copper content increases the resistance. The optimum copper content for most conditions seems to be about 85%. On the other hand, attack by sulphur and sulphur compounds is more or less proportional to the zinc content, the higher the zinc the greater the resistance.

MACHINABILITY

All the alloys are machinable, although usually considered "tough" in machining, due to the tenacity of the chips. Machinability increases as the copper content decreases, the better machining alloys being

Soft annealed Red Brass. Magnification 100 times, (composed entirely of twinned Alpha grains.)

those with from 58% to 63% copper. Where really good machinability is needed, one of the lead-bearing brasses listed in the next section should be used in preference to any here listed.

The following tables outline the compositions of the preferred alloys, their general properties, available forms, and typical uses.

The tabular data in this section are supplemented by some graphical data presented on page 14.

FORMS AND USES

MUNTZ METAL (Yellow Metal)

Forms Available: Sheet, Rod, Wire and Tube

Suggested Uses: Architectural trim, brazing rod, valve stems, sheet and condenser tubes.

EXTRUDED RIVET METAL

Forms Available: Wire

Suggested Uses: Rivets and screws.

HIGH BRASS (Yellow or Drawing Brass)

Forms Available: Sheet, Strip and Wire

Suggested Uses: Stamping, blanking, drawing, spinning, forming, lamp fixtures, hardware, kick plates, eyelets, radiator tanks and cores, stencils, etching, springs, pins, screws, rivets, push plates, screw shells, socket shells, drawn shapes, flashlight shells, grillwork, fasteners, chain, bead chain.

EYELET BRASS (Spinning Brass)

Forms Available: Sheet and Strip

Suggested Uses: Deep drawing, eyelets, springs, screw shells, socket shells fasteners, bead chain.

CARTRIDGE BRASS (Spring, Spinning or Extra Quality Brass)

Forms Available: Sheet, Strip, Wire and Tube

Suggested Uses: Cartridges, musical instruments, eyelets, tubes, spinning, drawing, springs.

BRAZING BRASS (Best Quality Brass)

Forms Available: Sheet, Strip and Wire

Suggested Uses: Drawing, spinning, eyelets, springs, musical instruments, uses requiring brazing.

FORMS AND USES

LOW BRASS (Red Brass 80%)

Forms Available: Sheet, Strip, Wire and Tube

Suggested Uses: Drawing, forming, ornamental, and architectural work, clock dials, flexible hose, bellows.

RICH LOW BRASS

Forms Available: Wire

Suggested Uses: Fourdrinier Wire.

RED BRASS (Red Brass 85%)

Forms Available: Sheet, Strip, Wire and Tube

Suggested Uses: Hardware, trim bronze, radiator cores, fasteners, plumbing pipe, condenser tubes, flexible hose, costume jewelry, rouge boxes, pickling crates, screw shells, sockets, eyelets, electrical conduit.

COMMERCIAL BRONZE (Commercial Bronze 90%)

Forms Available: Sheet, Strip, Wire and Tube

Suggested Uses: Screen wire, screen cloth, hardware, door knobs, escutcheons, screw shells, kick plates, trim, weatherstrip, forgings, grillwork, screws, rivets, primer caps, projectile rotating bands, costume jewelry.

GILDING METAL (Commercial Bronze 95%)

Forms Available: Sheet, Strip and Wire

Suggested Uses: Drawing, spinning, forming.

PROPERTIES (Fabrication)

NAME	Composition Copper	Composition Zinc	Approximate Relative Suitability for Being Worked: Cold	Hot	Best Temperature For Hot Working Deg. F	Approximate Relative Suitability for Being Welded: Gas	Carbon Arc	Metallic Arc	Resistance	Approx. Relative Machinability (Free Cutting Brass = 100)
Muntz Metal	59	41	Fair	Excellent	1150-1300	Good	Fair	Poor	Good	40
Extruded Rivet Metal	63	37	Good	Good	1300-1400	Good	Fair	Poor	Good	40
High Brass	66	34	Excellent	Fair	1400-1500	Good	Fair	Poor	Fair	30
Eyelet Brass	68	32	Excellent	Fair	1400-1500	Good	Fair	Poor	Fair	30
Cartridge Brass	70	30	Excellent	Fair	1400-1500	Good	Fair	Poor	Fair	30
Brazing Brass	75	25	Excellent	Fair	1450-1550	Good	Fair	Poor	Poor	30
Low Brass	80	20	Excellent	Good	1500-1600	Good	Fair	Poor	Poor	30
Rich Low Brass	83	17	Excellent	Good	1450-1600	Good	Fair	Poor	Poor	30
Red Brass	85	15	Excellent	Excellent	1450-1650	Good	Good	Fair	Poor	30
Commercial Bronze	90	10	Excellent	Excellent	1400-1600	Good	Good	Fair	Poor	20
Gilding Metal	95	5	Excellent	Excellent	1400-1600	Fair	Good	Good	Poor	20

(Physical)

Name	Density Lbs. Per Cu. Inch	Melting Point Deg. F	Coefficient of Thermal Expansion, Ave. 25°C to 300°C X 10^{-6}	Electrical Conductivity % IACS	Thermal Conductivity Cal/sq. cm/cm/sec/deg. C at 20°C
Muntz Metal	0.303	1660	20.8	28	0.30
Extruded Rivet Metal	0.305	1690	20.5	26	0.29
High Brass	0.306	1710	20.2	26	0.29
Eyelet Brass	0.307	1730	20.0	27	0.29
Cartridge Brass	0.308	1750	19.9	27	0.29
Brazing Brass	0.310	1800	19.5	30	0.31
Low Brass	0.313	1830	19.1	33	0.34
Rich Low Brass	0.315	1850	18.9	35	0.36
Red Brass	0.316	1870	18.7	38	0.38
Commercial Bronze	0.318	1910	18.4	44	0.45
Gilding Metal	0.320	1950	18.1	55	0.58

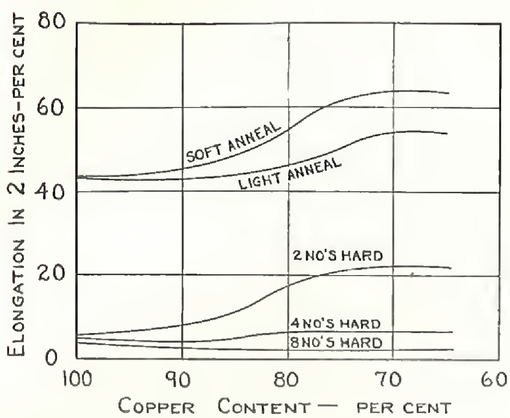
NOTE: The above figures are average and not to be used for specification purposes.

(Hardness and Tensile) PROPERTIES

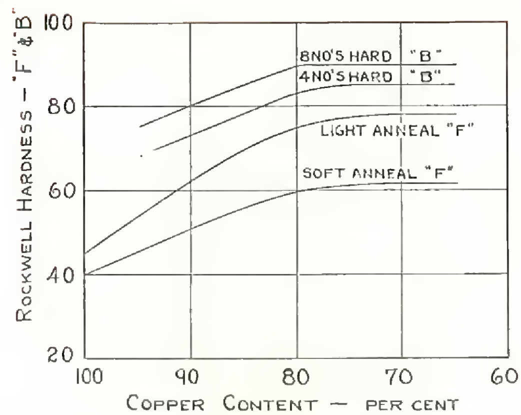
NAME	Form for Which Hardness and Tensile Properties Are Given	Temper	Rockwell Hardness F	Rockwell Hardness B	Tensile Strength Lbs./Sq. In.	Elongation in 2 In. Per Cent
Muntz Metal	0.040″ Sheet	Hot Rolled	80		54,000	45
	0.040″ Sheet	Cold Rolled			80,000	5
Extruded Rivet Metal	0.100″ Wire	Rivet			60,000	30
High Brass	0.040″ Sheet	0.025 mm Anneal	70		52,000	56
	0.040″ Sheet	0.070 mm Anneal	60		46,000	64
	0.040″ Sheet	Hard		85	76,000	7
	0.040″ Sheet	Spring		90	92,000	3
	0.100″ Wire	Rivet			60,000	30
	0.100″ Wire	Spring			125,000	
Eyelet Brass	0.040″ Sheet	0.025 mm Anneal	70		52,000	56
	0.040″ Sheet	0.070 mm Anneal	60		46,000	64
	0.040″ Sheet	Hard		85	76,000	7
	0.040″ Sheet	Spring		90	92,000	3
Cartridge Brass	0.040″ Sheet	0.025 mm Anneal	70		52,000	56
	0.040″ Sheet	0.070 mm Anneal	60		46,000	64
	0.040″ Sheet	Hard		85	76,000	7
	0.040″ Sheet	Spring		90	92,000	3
Brazing Brass	0.040″ Sheet	0.025 mm Anneal	69		51,000	53
	0.040″ Sheet	0.070 mm Anneal	58		45,000	62
	0.040″ Sheet	Hard		85	76,000	7
	0.040″ Sheet	Spring		90	92,000	3
	0.100″ Wire	Spring			125,000	
Low Brass	0.040″ Sheet	0.015 mm Anneal	75		47,000	47
	0.040″ Sheet	0.050 mm Anneal	60		43,000	55
	0.040″ Sheet	Hard		83	75,000	7
	0.040″ Sheet	Spring		90	91,000	3
	0.100″ Wire	Spring			120,000	
Rich Low Brass	0.100″ Wire	Soft			42,000	
Red Brass	0.040″ Sheet	0.015 mm Anneal	71		45,000	43
	0.040″ Sheet	0.030 mm Anneal	60		42,000	47
	0.040″ Sheet	Hard		78	71,000	5
	0.040″ Sheet	Spring		85	83,000	3
Commercial Bronze	0.040″ Sheet	0.015 mm Anneal	62		41,000	42
	0.040″ Sheet	0.030 mm Anneal	53		38,000	45
	0.040″ Sheet	Hard		74	64,000	4
	0.040″ Sheet	Spring		80	73,000	3
Gilding Metal	0.040″ Sheet	0.015 mm Anneal	55		38,000	42
	0.040″ Sheet	0.030 mm Anneal	50		36,000	44
	0.040″ Sheet	Hard		65	55,000	4
	0.040″ Sheet	Spring		77	65,000	3

NOTE: The above figures are average and not to be used for specification purposes.

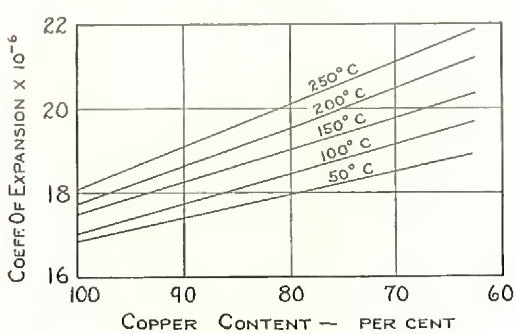
PROPERTIES (Physical)



Effect of Copper Content on Elongation of Brasses Containing from 100 to 65% Copper for Various Nominal Tempers. All tests made on 0.040″ strip.

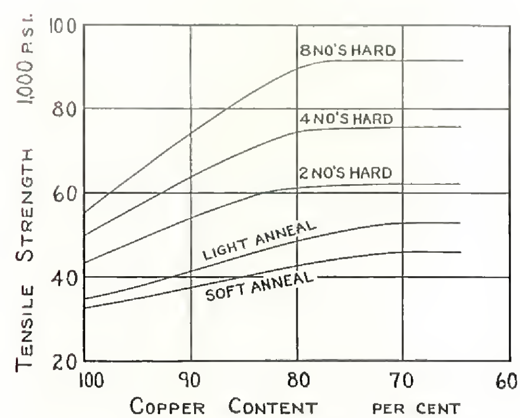


Effect of Copper Content on Rockwell Hardness of Brasses Containing from 100 to 65% Copper for Various Nominal Tempers. Tests made on 0.040″ strip.

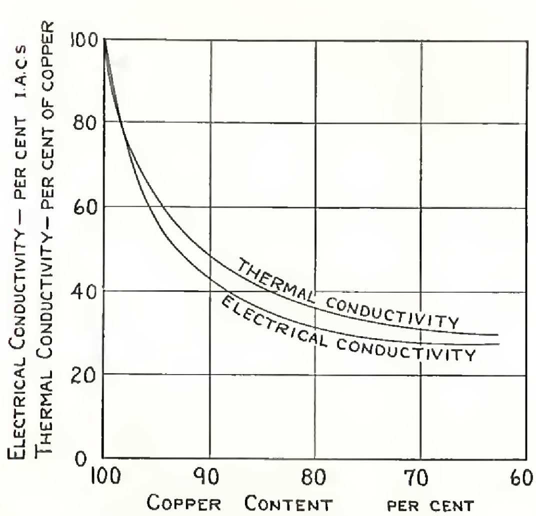


Effect of Copper Content of Coefficient of Linear Expansion at Various Temperatures.

(Bur. Stds. Sci. Paper 410)

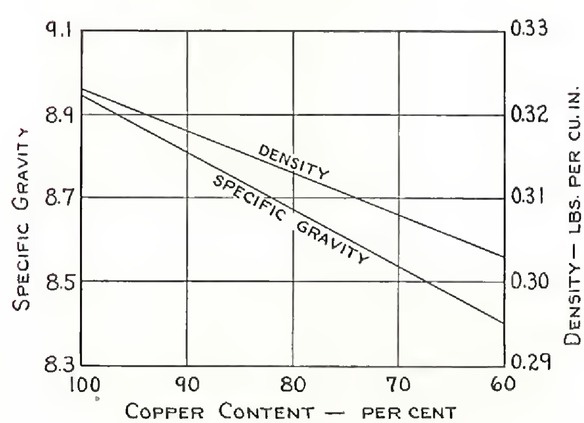


Effect of Copper Content on Tensile Strength of Brasses Containing from 100 to 65% Copper for Various Nominal Tempers. Tests made on 0.040″ strip.



Effect of Copper Content on Electrical and Thermal Conductivities of Brasses from 100 to 63% Copper.

(Smith, Proc. Inst. Met. Div., A.I.M.E. [1930], 100)



Effect of Copper Content on Specific Gravity and Density of Brasses from 100 to 60% Copper Content.



LEAD-BEARING BRASSES BY CHASE

The usual purpose in adding lead to any brass is to improve machining characteristics. All leaded alloys, containing more than a fraction of a per cent lead, are readily machined, ease of machining increasing with lead content. Cold ductility and malleability of the alloys are but slightly impaired with low lead contents, but much more as the lead is increased. Hot workability is in general materially lowered except for those alloys containing from 55% to 62% copper. Most alloys with the higher lead contents are designed specifically for machining purposes where there is little or no need of ability to be otherwise worked. With the lower and intermediate lead contents, the alloys are the result of a compromise between ease of machinability and workability.

Such properties as strength, hardness, corrosion resistance, melting point, color, conductivity, coefficient of expansion and specific gravity are for all practical purposes not altered by the presence of lead and are the same as found in non-leaded alloys of similar copper content.

Compositions, properties, available forms, and typical uses are given on the following pages.

Left: Drill Temper Free Cutting Brass Rod. Magnification 100 X. (Round black dots are lead particles.)

Right: Forging Brass as forged. Magnification 100 X. (The larger twinned grains are Alpha, the smaller irregularly shaped patches Beta.)

FORMS AND USES

ARCHITECTURAL BRONZE

Forms Available: Extruded Shapes and Rod
Suggested Uses: Extruded shapes, butts, hinges, forgings, valve stems, lock bodies.

FORGING BRASS

Forms Available: Rod
Suggested Uses: Forgings, tire valve stems.

FREE CUTTING BRASS

Forms Available: Rod
Suggested Uses: Hardware, screw machine products, extruded shapes (drawn), pinions, gears.

FREE CUTTING COMMERCIAL BRONZE (Hardware Bronze)

Forms Available: Rod
Suggested Uses: Hardware, screw machine products, pickling crates, forgings.

LEADED COPPER

Forms Available: Rod
Suggested Uses: Free cutting copper, torch tips.

ENGRAVERS' BRASS (Clock Brass)

Forms Available: Sheet
Suggested Uses: Engraving, channel plate clock and watch backs, gears.

STAMPING BRASS (Common High Brass)

Forms Available: Sheet and Strip
Suggested Uses: Stamping, drawing, forming, switch plates.

LEADED HIGH BRASS (Semi-leaded Brass) (Butt Brass) (Matrix Brass)

Forms Available: Sheet, Strip, Rod and Wire
Suggested Uses: Moderate drawing accompanied by machining, free machining screws and rivets, tire valve stems, moderate cold heading.

FORMS AND USES

FREE CUTTING HIGH BRASS (Bearing Brass)

Forms Available: Sheet
Suggested Uses: Engraving, bushings, moderate drawing combined with machinability.

TUBE BRASS (High Brass)

Forms Available: Tube
Suggested Uses: Plumbing pipe, plumbing goods, pump liners, windshield tubing, flashlight shells, special shapes.

FREE CUTTING TUBE BRASS (Leaded High Brass)

Forms Available: Tube
Suggested Uses: Screw machine products.

(Fabrication) PROPERTIES

NAME	Composition			Approximate Relative Suitability for Being Worked		Best Temperature For Hot Working Deg. F	Approximate Relative Suitability for Being Welded				Approx. Relative Machinability (Free Cutting Brass = 100)
	Copper	Zinc	Lead	Cold	Hot		Gas	Carbon Arc	Metallic Arc	Resistance	
Architectural Bronze	58	39	3	Poor	Excellent	1200-1300	Fair	Poor	Poor	Poor	90
Forging Brass	60	38.25	1.75	Poor	Excellent	1250-1550	Fair	Poor	Poor	Poor	80
Free Cutting Brass	62	34.75	3.25	Poor	Good	1300-1400	Fair	Poor	Poor	Poor	100
Free Cutting Commercial Bronze	89	9	2	Good	Good	1400-1500	Fair	Fair	Fair	Poor	90
Leaded Copper	99	—	1	Good	Good	1400-1550	Poor	Fair	Fair	Poor	80
Engravers' Brass	63.5	34.5	2	Fair	Fair	1300-1400	Fair	Fair	Fair	Poor	90
Stamping Brass	65	34.7	0.3	Good	Poor	—	Good	Fair	Fair	Fair	50
Leaded High Brass	65	34	1	Good	Poor	—	Good	Fair	Fair	Poor	70
Free Cutting High Brass	67	29	4	Fair	Poor	—	Fair	Poor	Fair	Poor	100
Tube Brass	66.5	33	0.5	Excellent	Poor	—	Good	Fair	Fair	Poor	60
Free Cutting Tube Brass	65.5	32.75	1.75	Fair	Poor	—	Fair	Fair	Fair	Poor	80

NOTE: The above figures are average and not to be used for specification purposes.

PROPERTIES (Physical)

Name	Density Lbs. per Cu. Inch	Melting Point Deg. F	Coefficient of Thermal Expansion, Ave. 25°C to 300°C X 10^{-6}	Electrical Conductivity % IACS	Thermal Conductivity Cal/sq. cm/cm/sec/deg. C at 20°C
Architectural Bronze	0.306	1630	20.9	30	0.30
Forging Brass	0.305	1630	20.7	27	0.29
Free Cutting Brass	0.307	1630	20.5	26	0.28
Free Cutting Commercial Bronze	0.320	1900	18.5	41	0.43
Leaded Copper	0.323	1980	17.9	99	0.94
Engravers' Brass	0.307	1690	20.4	26	0.28
Stamping Brass	0.305	1700	20.3	26	0.29
Leaded High Brass	0.306	1700	20.3	26	0.29
Free Cutting High Brass	0.310	1720	20.1	26	0.29
Tube Brass	0.307	1720	20.2	26	0.29
Free Cutting Tube Brass	0.308	1710	20.3	26	0.29

(Hardness and Tensile)

Name	Form for Which Tensile Properties Are Given	Temper	Tensile Strength Lbs./Sq. In.	Elongation in 2 In. Per Cent
Architectural Bronze	1 In. Rod Shapes	Extruded Extruded & Stretched	54,000 60,000	45 25
Forging Brass	1 In. Rod	Forged	50,000	45
Free Cutting Brass	1 In. Rod	Drill	55,000	30
Free Cutting Commercial Bronze	1 In. Rod	Drill	45,000	30
Leaded Copper	1 In. Rod	Drill	40,000	30
Engravers' Brass	0.040″ Sheet 0.040″ Sheet	Half Hard (2 B&S Nos.) Hard (4 B&S Nos.)	62,000 75,000	20 7
Stamping Brass	0.040″ Sheet	0.025 mm Anneal	52,000	56
Leaded High Brass	0.040″ Sheet	0.025 mm Anneal Half Hard (2 B&S Nos.)	52,000 62,000	56 23
Free Cutting High Brass	0.040″ Sheet	Half Hard	62,000	23
Tube Brass	Tube	0.025 mm Anneal Hard	52,000 75,000	56 7
Free Cutting Tube Brass	Tube	0.025 mm Anneal Hard	52,000 75,000	56 7

NOTE: The above figures are average and not to be used for specification purposes.



SPECIAL BRASSES BY CHASE

When elements other than lead are added to various base brasses this usually is done in order to improve corrosion resistance, increase strength or ductility or both, or possibly to enhance welding characteristics. In general, the properties of such special brasses vary with the copper content quite similarly to the straight copper-zinc alloys.

The most common addition element is tin, which imparts appreciable hardening and strengthening. In the alloys of about 60% copper tin also very markedly improves corrosion resistance. This improvement is mainly and specifically the result of a reduction of apparent dezincification, a type of attack to which such alloys are prone.

Service records indicate clearly that Naval Brass is a decidedly more corrosion resistant alloy than Muntz metal listed in the section on Brasses. Tin added to high brasses results in the same type of improvement, but to a lesser degree. In special brasses of higher copper content and where such contain no other added element than the tin, it is found that the tin addition is of relatively less value in this respect.

Iron is a powerful hardener and drastically reduces grain size for a given annealing treatment. However, as it strongly reduces ductility and makes it difficult to accurately control temper in the alpha brasses, it is seldom used except in such strong hot working alloys as manganese bronze.

Aluminum aids materially in resistance to tarnishing as well as to oxidation at moderately elevated temperatures. In addition, it specifically prevents impingement type of corrosion attack in condenser tubes, although at the expense of increasing susceptibility to dezincification. The combination of aluminum and tin in an alloy of about 82% copper results in practical immunity to both forms of attack.

Many other special brasses are made but not as widely used. Those listed in the accompanying tables are the more common and generally useful. These tables show names, compositions, properties, available forms, and suggested uses.

CHASE

FORMS AND USES

NAVAL BRASS

Forms Available: Sheet, Strip, Rod and Tube
Suggested Uses: Structural uses, marine hardware, propeller shafts, welding rod, bolts, nuts, balls, forgings.

LEADED NAVAL BRASS

Forms Available: Rod
Suggested Uses: Valve stems, screw machine products, forgings.

MANGANESE BRONZE

Forms Available: Sheet and Rod
Suggested Uses: Structural uses, welding rod, forgings, bolts, nuts, balls, valve stems.

ADMIRALTY BRASS

Forms Available: Sheet, Tube and Wire
Suggested Uses: Condenser tubes, distiller tubes, heat exchanger tubes, plumbing pipe, ferrules, filter wire, tube sheets.

ALUMINUM BRASS

Forms Available: Tube
Suggested Uses: Condenser tubes, distiller tubes, heat exchanger tubes.

AD-ALUMINUM

Forms Available: Tube
Suggested Uses: Condenser tubes, distiller tubes, heat exchanger tubes.

REDALLOY

Forms Available: Tube
Suggested Uses: Condenser tubes, distiller tubes, heat exchanger tubes.

(Fabrication) PROPERTIES

NAME	Composition			Approximate Relative Suitability for Being Worked		Best Temperature For Hot Working Deg. F	Approximate Relative Suitability for Being Welded				Approx. Relative Machinability (Free Cutting Brass = 100)
	Copper	Zinc	Miscellaneous	Cold	Hot		Gas	Carbon Arc	Metallic Arc	Resist.	
Naval Brass	60	39.25	0.75 Tin	Fair	Excellent	1200-1350	Good	Fair	Poor	Good	30
Leaded Naval Brass	60	37.75	0.75 Tin 1.5 Lead	Poor	Good	1200-1350	Fair	Fair	Poor	Poor	70
Manganese Bronze	57.5	40.45	1 Tin 1 Iron 0.05 Manganese	Poor	Excellent	1150-1300	Good	Fair	Poor	Good	30
Admiralty Brass	71	28	1 Tin	Excellent	Fair	1150-1250	Good	Good	Poor	Fair	30
Aluminum Brass	76	22	2 Aluminum	Excellent	Fair	1400-1600	Good	Good	Poor	Good	30
Ad-Aluminum	82	15	2 Aluminum 1 Tin	Excellent	Fair	1400-1600	Good	Good	Poor	Fair	30
Redalloy	85	14	1 Tin	Excellent	Good	1400-1600	Good	Good	Poor	Poor	30

(Physical)

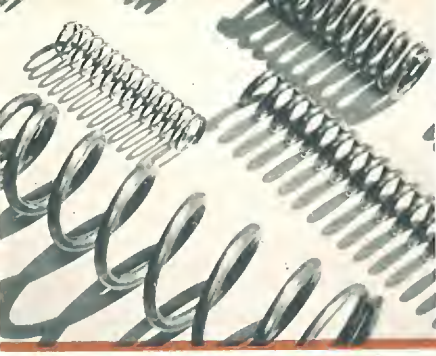
Name	Density Lbs. per Cu. Inch	Melting Point Deg. F	Coefficient of Thermal Expansion, Ave. 25°C to 300°C X 10^{-6}	Electrical Conductivity % IACS	Thermal Conductivity Cal/sq. cm/cm/sec/deg. C at 20°C
Naval Brass	0.304	1630	21.2	25	0.28
Leaded Naval Brass	0.305	1620	21.2	25	0.28
Manganese Bronze	0.303	1620	——	25	0.24
Admiralty Brass	0.308	1720	20.2	25	0.26
Aluminum Brass	0.301	1780	18.5	23	0.24
Ad-Aluminum	0.305	1810	18.5	22	0.23
Redalloy	0.316	1860	18.7	31	0.32

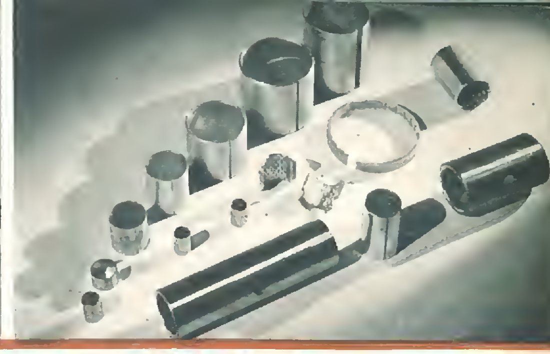
NOTE: The above figures are average and not to be used for specification purposes.

PROPERTIES (Tensile)

Name	Form for Which Tensile Properties Are Given	Temper	Tensile Strength Lbs./Sq. In.	Elongation in 2 In. Per Cent
Naval Brass	0.040″ Sheet	Hot Rolled	55,000	45
	1 In. Rod	Annealed	55,000	45
	1 In. Rod	Quarter Hard	63,000	30
	1 In. Rod	Half Hard	70,000	25
Leaded Naval Brass	1 In. Rod	Annealed	55,000	45
	1 In. Rod	Quarter Hard	63,000	30
	1 In. Rod	Half Hard	70,000	25
Manganese Bronze	0.040″ Sheet	Hot Rolled	60,000	35
	1 In. Rod	Annealed	65,000	35
	1 In. Rod	Quarter Hard	75,000	25
	1 In. Rod	Half Hard	80,000	20
Admiralty Brass	Tube	0.025 mm Anneal	50,000	70
Aluminum Brass	Tube	0.025 mm Anneal	52,000	70
Ad-Aluminum	Tube	0.025 mm Anneal	53,000	65
Redalloy	Tube	0.030 mm Anneal	42,000	48

NOTE: The above figures are average and not to be used for specification purposes.





TIN BRONZES BY CHASE

The tin bronzes are frequently referred to as phosphor bronzes due to the very general practice of deoxidizing these with phosphorus. They are as a class characterized by high strength, good ductility, great resilience, and excellent corrosion resistance. Good hot workability is found in those containing up to about 2% tin and low phosphorus. Those containing less than about 4% tin and little or no phosphorus can be hot worked to a lesser extent. Good cold workability is shown by all. However, the hardness and the power required to work increases with increasing tin.

Due to the relatively high price and scarcity of tin as compared to zinc, the tin bronzes have not met with as wide application as the various brasses. Only where they perform certain functions particularly well have they come into wide use. The general field of springs and bearings (more often cast than wrought) are cases in point. The low tin content rod (Corvic Bronze) has been found particularly suited to welding.

CHASE

The more usual tin or phosphor bronzes with their uses and properties are shown on the following pages.

Left: 5% Phosphor Bronze. Magnification 100 X, (spring temper showing hard worked structure).

Right: 444 Bronze Sheet. Magnification 100 X, (background composed of Alpha grains, irregular dark areas are lead).

FORMS AND USES

CORVIC BRONZE

Forms Available: Wire
Suggested Uses: Welding rod, rivets, screen cloth.

5% PHOSPHOR BRONZE (Grade A)

Forms Available: Strip, Rod and Wire
Suggested Uses: Springs, bridge bearing plates, wire rope, fasteners.

LEADED 5% PHOSPHOR BRONZE (Grade B)

Forms Available: Strip, Wire and Rod
Suggested Uses: Screw machine products.

8% PHOSPHOR BRONZE (Grade C)

Forms Available: Strip, Rod and Wire
Suggested Uses: Springs, welding rod, bridge bearing plates.

444 BRONZE (Free Turning Phosphor Bronze)

Forms Available: Strip, Rod, Wire and Tube
Suggested Uses: Bearings, bushings, screw machine products, condenser tubes, acid resisting uses, thrust washers.

PROPERTIES (Fabrication)

NAME	Composition			Approximate Relative Suitability for Being Worked		Best Temperature For Hot Working Deg. F.	Approximate Relative Suitability for Being Welded				Approx. Relative Machinability (Free Cutting Brass = 100)
	Copper	Tin	Misc.	Cold	Hot		Gas	Carbon Arc	Metallic Arc	Resist.	
Corvic Bronze	98.2	1.5	0.3 Phos.	Excellent	Good	1450-1550	Good	Good	Good	Fair	30
5% Phosphor Bronze (A)	94.75	5	0.25 Phos.	Excellent	Poor	..	Good	Good	Good	Good	20
Leaded 5% Phos. Bronze (B)	93.75	5	0.25 Phos. 1 Lead	Fair	Poor	..	Poor	Poor	Fair	Poor	50
8% Phosphor Bronze (C)	91.75	8	0.25 Phos.	Good	Poor	..	Good	Good	Good	Excellent	20
444 Bronze (Free Turning Phos. Bronze)	88	4	4 Zinc 4 Lead	Fair	Poor	..	Poor	Poor	Fair	Poor	100

NOTE: The above figures are average and not to be used for specification purposes.

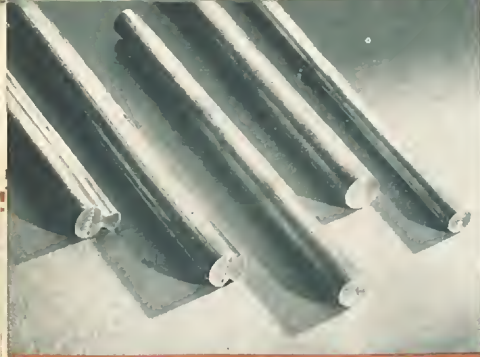
(Physical) PROPERTIES

Name	Density Lbs. Per Cu. Inch	Melting Point Deg. F	Coefficient of Thermal Expansion, Ave. 25°C to 300°C X 10^{-6}	Electrical Conductivity % IACS	Thermal Conductivity Cal/sq. cm/cm/sec/deg. C at 20°C
Corvic Bronze	0.321	1970	17.7	42	0.43
5% Phosphor Bronze (A)	0.320	1920	17.8	18	0.20
Leaded 5% Phosphor Bronze (B)	0.322	1920	17.8	18	0.20
8% Phosphor Bronze (C)	0.319	1880	18.2	13	0.15
444 Bronze	0.321		17.3	19	0.13

(Hardness and Tensile)

Name	Form for Which Hardness and Tensile Properties Are Given	Temper	Rockwell Hardness		Tensile Strength Lbs./Sq. In.	Elongation in 2 In. Per Cent
			F	B		
Corvic Bronze	0.100″ Wire	Soft			42,000	42
		Spring			95,000	
5% Phosphor Bronze (A)	0.040″ Sheet	Soft	75		51,000	55
	0.040″ Sheet	Hard (4 B&S Nos.)		91	85,000	7
	0.040″ Sheet	Spring (8 B&S Nos.)		97	103,000	3
	0.100″ Wire	Spring			130,000	
Leaded 5% Phosphor Bronze (B)	0.040″ Sheet	Soft	75		51,000	55
	0.040″ Sheet	Hard (4 B&S Nos.)		91	85,000	7
	0.040″ Sheet	Spring (8 B&S Nos.)		97	103,000	3
	1″ Rod	Hard			90,000	15
8% Phosphor Bronze (C)	0.040″ Sheet	Soft		50	60,000	70
	0.040″ Sheet	Hard (4 B&S Nos.)		93	93,000	12
	0.040″ Sheet	Spring (8 B&S Nos.)		100	111,000	5
	0.100″ Wire	Spring			145,000	
444 Bronze	0.040″ Sheet	Soft	65		45,000	55
	1″ Rod	Hard			65,000	20

NOTE: The above figures are average and not to be used for specification purposes.



CONDUCTIVITY BRONZES BY CHASE

There is one general field of use where a combination of high strength and relatively high electrical conductivity is paramount. This comprises trolley wires, where resistance to abrasion is important, conductors for long span transmission circuits and telephone drop conductors where strength is relatively more important than conductivity. Usually the high strength is necessary to withstand ice and wind loads and to permit wider spacing of poles or hangers. Unfortunately, most elements when added to copper to improve strength markedly reduce conductivity. The result is therefore a compromise between greatest attainable strength and reasonable conductivity.

The alloys listed here might well be, and in a few instances are, used for other uses than high strength high conductivity members. Generally, however there may be found other alloys better suited to or more economical for such other uses. Therefore the data given herewith are confined strictly to those of interest in the conductivity field.

All the alloys are close to copper in density, corrosion resistance, etc. The density of all may be taken as 0.321 pounds per sq. inch. All lend themselves nicely to severe cold working and all but the 55 and 30% conductivity alloys are readily hot worked. Those two can be hot worked but have to be handled somewhat more carefully than the others.

The more common alloys of this group are:

Name	Composition			Electrical Conductivity % IACS (Minimum)	Tensile Strength, p.s.i. (min.)	
	Copper	Cadmium	Tin		0.102″ (10 B&S) Hard Drawn	0.460″ (4/0 B&S) Hard Drawn
85% Conductivity Bronze	99.0	1.0	—	85	79,200	61,500
80% Conductivity Bronze	98.85	1.15	—	80	83,400	65,000
65% Conductivity Bronze	99.5	—	0.5	65	75,100	61,000
55% Conductivity Bronze	98.7	0.8	0.5	55	90,000	72,000
40% Conductivity Bronze	98.5	—	1.5	40	86,000	69,000
30% Conductivity Bronze	98.2	—	1.8	30	100,000	71,000

NOTE: The above figures are average and not to be used for specification purposes.

NICKEL SILVERS AND NICKEL ALUMINUM BRONZES BY CHASE

The nickel silvers (seldom, but more properly, called nickel brasses) find application because of their color, corrosion resistance, high strength and ductility, and ease of working. They have long been used as a base for flat and hollow silver plated table ware. The 12% leaded alloy has gained almost universal acceptance for keys and cylinder locks.

The color of these alloys depends largely on the nickel content. With 5% nickel a yellowish white color results. At 10% nickel the alloy is fairly white although a slight yellow tinge remains. At 15% nickel the color is a very clear white and comparatively little improvement results from progressively increasing the nickel content beyond that point. In general, the resistance to tarnishing is good and improves in proportion to the change in initial basic color.

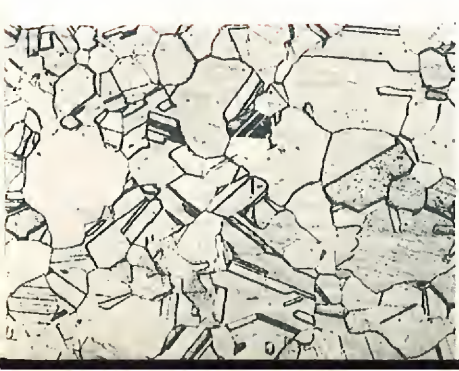
Cupro-nickel and nickel silvers containing 20 to 30% nickel are finding increasing use in the form of condenser tubes due to their excellent corrosion resistance. They are particularly effective for salt water installations where service is unusually severe.

Two quite different types of nickel-aluminum bronze are available. Type A is very ductile and malleable and lends itself to severe cold working. Excellent mechanical properties are shown in both the annealed and worked states. But its greatest field of use has come from its excellent corrosion resistance which approaches that of the Cupro-nickels.

Type B alloy should be used where advantage can be taken of its capacity for precipitation hardening. It is soft and ductile as quenched and may be extensively cold worked. Subsequent heat treatment at a relatively low temperature greatly increases the strength, hardness, and stiffness.

CHASE

Properties, forms and uses are listed on the following pages.



Left: Nickel Aluminum Bronze (age hardening type) as quenched. Magnification 100 X.

Right: Nickel Aluminum Bronze (age hardening type) as aged. Magnification 100 X.

FORMS AND USES

12% NICKEL SILVER

Forms Available: Strip and Wire
Suggested Uses: Costume jewelry, tableware, hollow ware, base for silver plated ware, screen wire, screen cloth.

FREE-CUTTING 12% NICKEL SILVER

Forms Available: Strip
Suggested Uses: Keys.

13% EXTRUDED NICKEL SILVER

Forms Available: Rod and Extruded Shapes
Suggested Uses: Architectural shapes.

18% NICKEL SILVER

Forms Available: Strip and Wire
Suggested Uses: Drawing, spinning, tableware, hollow ware, base for silver plated ware.

20% NICKEL SILVER

Forms Available: Plate and Tube
Suggested Uses: Condenser plates, condenser tubes, ferrules, heat exchanger tubes.

30% CUPRO-NICKEL

Forms Available: Plate and Tube
Suggested Uses: Condenser plates, condenser tubes, ferrules, heat exchanger tubes.

NICKEL-ALUMINUM BRONZE, Type A

Forms Available: Plate and Tube
Suggested Uses: Condenser plates, condenser tubes, ferrules, heat exchanger tubes.

NICKEL-ALUMINUM BRONZE, Type B

Forms Available: Plate, Sheet and Rod
Suggested Uses: Bearing plates, marine hardware, pickling racks, valve stems, tie-rods, forgings, pump rods and propeller shafts.

CHASE NICKEL SILVERS AND NICKEL ALUMINUM BRONZES

(Fabrication) PROPERTIES

NAME	Composition: Copper	Nick.	Zinc	Lead	Al.	Approximate Relative Suitability for Being Worked: Cold	Hot	Best Temperature For Hot Working Deg. F	Approximate Relative Suitability for Being Welded: Gas	Carbon Arc	Metallic Arc	Resist.	Approx. Relative Machinability (Free Cutting Brass = 100)
12% Nickel Silver	64	12	24	..	..	Excellent	Poor	..	Good	Fair	Fair	Excellent	20
Free-Cutting 12% Nickel Silver	64	12	23	1	..	Good	Poor	..	Fair	Poor	Fair	Poor	50
13% Extruded Nickel Silver	41.5	13	44	1.5	..	Poor	Good	1300-1450	Fair	Poor	Fair	Poor	70
18% Nickel Silver	65	18	17	..	..	Excellent	Poor	..	Good	Fair	Good	Excellent	20
20% Nickel Silver	75	20	5	..	..	Excellent	Good	1700-1850	Good	Fair	Good	Excellent	20
30% Cupro-Nickel	70	30	..	..	..	Good	Good	1700-1900	Good	Fair	Good	Excellent	20
Nickel-Aluminum Bronze, Type A	92	4	..	..	4	Excellent	Good	1400-1700	Good	Good	Good	Excellent	20
Nickel-Aluminum Bronze, Type B	91	7.5	..	..	1.5	Excellent	Excellent	1400-1700	Good	Good	Good	Excellent	20

(Physical)

Name	Density Lbs. Per Cu. Inch	Melting Point Deg. F	Coefficient of Thermal Expansion, Ave. 25°C to 300°C X 10^{-6}	Electrical Conductivity % IACS	Thermal Conductivity Cal/sq. cm/cm/sec/deg. C at 20°C
12% Nickel Silver	0.314	1900		7	0.10
Free-Cutting 12% Nickel Silver	0.315	1900		7	0.10
13% Extruded Nickel Silver	0.305	1700	19.1		
18% Nickel Silver	0.316	2030		6	0.08
20% Nickel Silver	0.320	2100	16.4	4.8	0.07
30% Cupro-Nickel	0.323	2230	16.2	6	0.09
Nickel-Aluminum Bronze, Type A	0.302	2000	17.0	15	0.16
Nickel-Aluminum Bronze, Type B	0.315	2055	$16.7^{\odot}$ $15.2^{\triangle}$	$13^{\odot}$ $17.5^{\triangle}$	$0.14^{\odot}$ $0.19^{\triangle}$

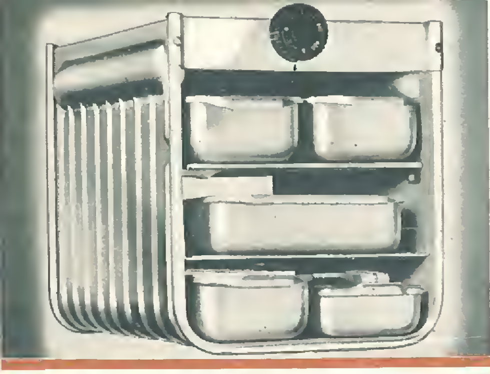
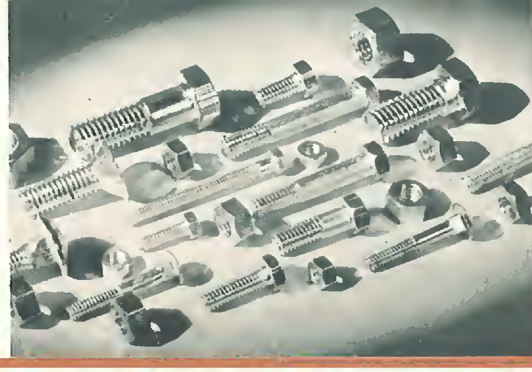
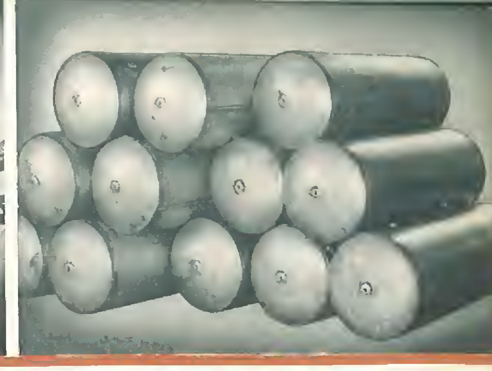
$\odot$ Soft. $\triangle$ Precipitation hardened.

NOTE: The above figures are average and not to be used for specification purposes.

PROPERTIES (Hardness and Tensile)

Name	Form for Which Hardness and Tensile Properties Are Given	Temper	Tensile Strength Lbs./Sq. In.	Elongation in 2 In. Per Cent	Rockwell Hardness F	Rockwell Hardness B
12% Nickel Silver	0.040″ Sheet	Soft	58,000	40		
		Hard (4 B&S Nos.)	85,000	4		
Free-Cutting 12% Nickel Silver	0.040″ Sheet	Soft	58,000	40		
		Hard (4 B&S Nos.)	85,000	4		
13% Extruded Nickel Silver	1 In. Rod	Extruded	90,000	7		
18% Nickel Silver	0.040″ Sheet	Soft	60,000	40		
		Hard (4 B&S Nos.)	87,000	3		
20% Nickel Silver	0.040″ Sheet	0.015 mm Anneal	55,000	35		
30% Cupro-Nickel	0.040″ Sheet	0.015 mm Anneal	60,000	33		
Nickel-Aluminum Bronze, Type A	0.040″ Sheet	Light Anneal	60,000	30	87	
	0.040″ Sheet	Soft Anneal	50,000	45	72	
	0.040″ Sheet	Hard	90,000	7		90
	0.040″ Sheet	Spring	104,000	5		95
Nickel-Aluminum Bronze, Type B	½″ Rod	Soft	50,000	38	68	
	½″ Rod	Age Hardened	105,000	13		93
	½″ Rod	Drawn and Age Hardened	115,000	10		95

NOTE: The above figures are average and not to be used for specification purposes.

OLYMPIC BRONZES BY CHASE

The silicon bronzes are copper base alloys having silicon as the main alloying element with or without small percentages of any of several other elements, as for instance zinc, iron, tin, aluminum, etc. Inasmuch as silicon has a much more powerful effect on the mechanical properties than most elements that can be added to copper, these bronzes have gained very wide commercial acceptance. Olympic Bronze is one of the outstanding developments in this field. It is available in several types as indicated in the tables herewith.

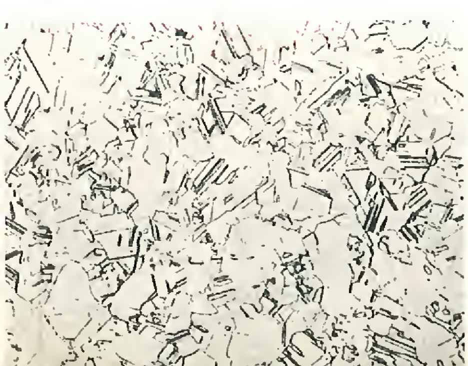
The type A Olympic Bronze which is the most important and widely applicable shows unusual strength combined with very high ductility. It is readily hot worked over a wide temperature range and is capable of extreme cold working of all kinds. In addition, the type A Olympic Bronze has extraordinary capacity for being readily welded by all processes. All these things contribute to the unusually varied commercial application of this alloy.

A considerable improvement in machinability is attained in the type B alloy at some sacrifice in hot working properties and a slight reduction in cold working properties. This type is available in rod form only.

The type D alloy is a lower silicon material designed especially for tubes requiring intermediate strength combined with high corrosion resistance.

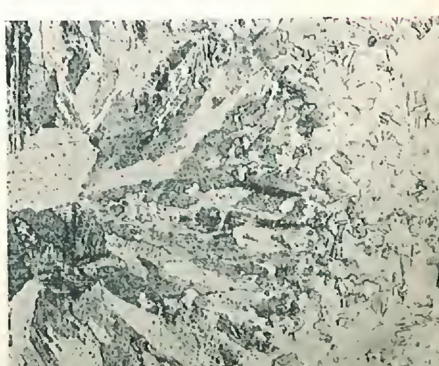
Compositions, properties, available forms, and suggested uses are given on the following pages. It is borne in mind that most engineering needs can be adequately fulfilled by one or more types of Olympic Bronze, produced in suitable tempers. More complete details are to be found in our Olympic Bronze catalog.

CHASE



Left: Annealed Olympic Bronze strip (Type A). Magnification 100 X.

Right: Spot Welded Olympic Bronze Strip. Magnification 75 X. (Fused spot is on left; end of joint between the two strips is on right.)



FORMS AND USES

OLYMPIC BRONZE, Type A

Forms Available: Sheet, Strip, Rod, Wire and Tube

Suggested Uses: Angles, bearing plates, bolts, burs, bushings, butts, cable, channels, clamps, cotter pins, drawing and stamping, evaporators, fasteners, forgings, Fourdrinier wire and cloth, hardware, hinges, I-beams, kettles, kickplates, lag screws, lock washers, marine hardware, mixing bowls, nails, nuts, pickling tanks and baskets, piston rings, piston rod, propeller shafts, range boilers, rivets, rod, screen wire and cloth, screen plates, screws, shafting, sheathing, skylight frames, springs, structural shapes, tacks, tanks, T-bars, tiller rope, turnbuckles, U-bolts, washers, welding rod, wire, window frames, condenser tubes, corrugated thermostat tubing.

OLYMPIC BRONZE, Type B

Forms Available: Rod

Suggested Uses: Screw machine parts.

OLYMPIC BRONZE, Type D

Forms Available: Tube

Suggested Uses: Condenser tubes, heater coils, plumbing pipe, tubes, electrical conduit.

OLYMPIC BRONZE, Type G

Forms Available: Sheet and Strip

Suggested Uses: Butts, drawing and stamping, evaporators, hardware, hinges, kick plates, sheathing, springs.

PROPERTIES (Fabrication)

TYPE OF OLYMPIC BRONZE	Composition				Approximate Relative Suitability for Being Worked		Best Temperature For Hot Working Deg. F.	Approximate Relative Suitability for Being Welded				Approx, Relative Machinability (Free Cutting Brass = 100)
	Cop.	Sil'n	Zinc	Lead	Cold	Hot		Gas	Carbon Arc	Metallic Arc	Resistance	
Type A	96	3	1		Excellent	Excellent	1250-1500	Excellent	Excellent	Excellent	Excellent	30
Type B	95.5	3	1	0.5	Good	Fair	1400-1500	Fair	Fair	Good	Poor	60
Type D	97.5	1.5	1		Excellent	Excellent	1250-1500	Excellent	Excellent	Excellent	Excellent	30
Type G	77	1	22		Excellent	Excellent	1350-1500	Excellent	Excellent	Excellent	Excellent	30

NOTE: The above figures are average and not to be used for specification purposes

(Physical) PROPERTIES

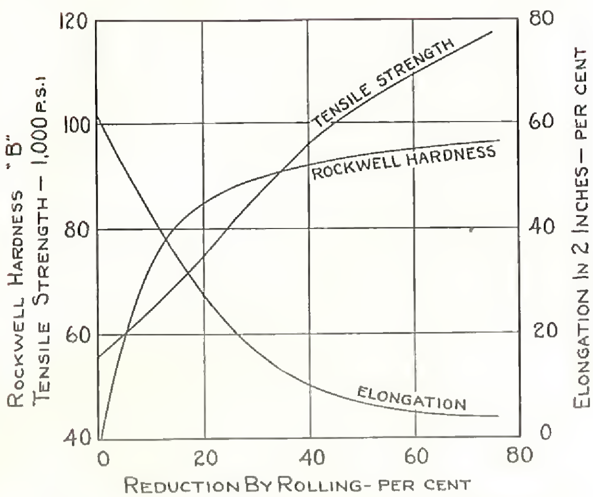
Name	Density Lbs. Per Cu. Inch	Melting Point Deg. F	Coefficient of Thermal Expansion, Ave. 25°C to 300°C X 10^{-6}	Electrical Conductivity % IACS	Thermal Conductivity Cal/sq. cm/cm/sec/deg. C at 20°C
Olympic Bronze, Type A	0.310	1880	18.0	7	0.08
Olympic Bronze, Type B	0.310	1880	18.0	7	0.08
Olympic Bronze, Type D	0.315	1940	17.9	12	0.13
Olympic Bronze, Type G	0.308	1775	19.3	13	

(Hardness and Tensile)

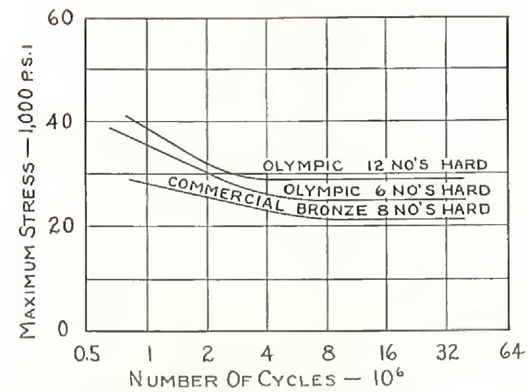
Names	Form for Which Hardness and Tensile Properties Are Given	Temper	Rockwell Hardness F	Rockwell Hardness B	Brinell Hardness	Tensile Strength Lbs./Sq. In.	Elongation in 2 In. Per Cent
Olympic Bronze, Type A	0.040" Sheet	0.040 mm. Anneal	75			56,000	65
	0.040" Sheet	0.015 mm. Anneal	90			65,000	58
	0.040" Sheet	Half Hard		86	160	76,000	26
	0.040" Sheet	Hard		91	185	93,000	10
	0.040" Sheet	Spring		96	215	110,000	5
	1 In. Rod	Half Hard		86	130	78,000	45
	1 In. Rod	Hard		90	155	93,000	35
	1 In. Rod	Extra Hard		94	195	108,000	25
	0.100" Wire	Rivet				70,000	35
	0.100" Wire	Quarter Hard				80,000	15
	0.100" Wire	Half Hard				90,000	8
	0.100" Wire	Hard				115,000	5
	0.100" Wire	Spring				135,000	3
Olympic Bronze, Type B	1 In. Rod	Half Hard		86	130	78,000	45
	1 In. Rod	Hard		90	155	93,000	35
	1 In. Rod	Extra Hard		94	195	108,000	25
Olympic Bronze, Type D	Tube	Annealed	68			45,000	55
		Half Hard		65		60,000	20
		Hard		70		65,000	14
		Extra Hard		82		80,000	6
Olympic Bronze, Type G	0.040" Sheet	0.015 mm. Anneal	93			68,000	46
	0.040" Sheet	0.035 mm. Anneal	83			63,000	55
	0.040" Sheet	Hard				96,000	12
	0.040" Sheet	Spring				117,000	3

NOTE: The above figures are average and not to be used for specification purposes.

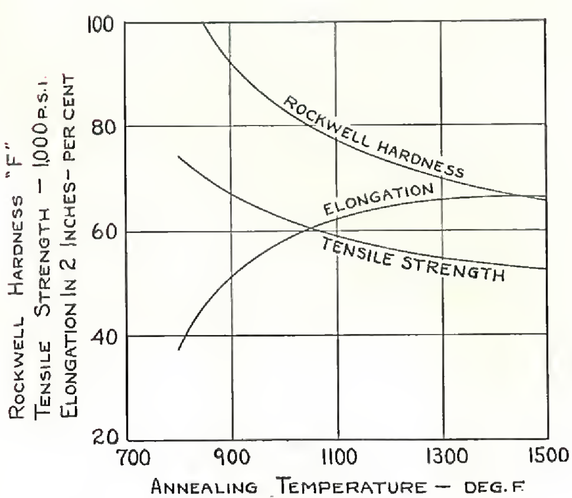
PROPERTIES (Physical)



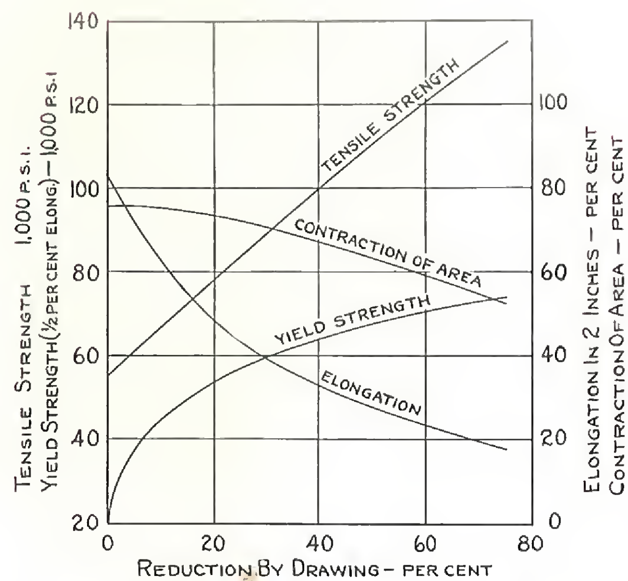
Tensile and Hardness Properties of Type "A" Olympic Bronze after Various Reductions by Rolling. All tests made on 0.040" strip.



Endurance Properties of Type "A" Olympic Bronze. All tests are made on 0.040" strip.



Tensile and Hardness Properties of Type "A" Olympic Bronze as Annealed at Various Temperatures. All tests made on 0.040" strip.



Tensile and Hardness Properties of Type "A" Olympic Bronze Rod Drawn to Various Total Reductions. All tests made on 1" dia. rod.

SUGGESTIONS FOR ORDERING

To insure getting a material best suited for any purpose, it is necessary to specify in some detail something with regard to each of the following factors:

Alloy	Size	Temper
Form	Tolerances	Finish

ALLOY

In the foregoing pages considerable space has been devoted to the alloys most commonly used and available and sufficient detailed information is given on each to enable reasonable choice to be made of alloys for various uses. Any of the listed alloys can properly be ordered by name or by actual nominal analysis. Special alloys not here listed and which for one reason or another might appear desirable would best be indicated both by name and by nominal composition.

FORM

The following definitions might appear at first sight unnecessary but the significance of these terms is not always the same in various alloy fields and the meanings here given are the ones ordinarily applied to the wrought copper alloys.

CHASE

"PLATE" is a term applied to heavy sheets whether produced by hot or cold rolling and regardless of the final temper or surface finish. There is no clear-cut distinction between plate and sheet but in general the heavier items are known as plate and the smaller and lighter ones as sheet.

"SHEET" is frequently very loosely applied in the industry to mean any product produced on sheet or strip rolls. In the strict sense, it would be confined to individual flat pieces cut to specified dimensions.

"STRIP" is properly applied to any sheet product produced in coil form but in addition is often applied to relatively thin and narrow materials even when cut to length and finished flat.

"ROD" signifies a material of any simple section produced by extrusion and drawing or rolling and drawing where the finished product is shipped in straight pieces of definitely specified or random lengths.

"WIRE" is material finished by drawing through a die and may be of any simple cross section but is finished in coils or is spooled or reeled. The distinction between rod and wire is therefore principally one of being straight or coiled rather than one of size of section.

"EXTRUDED SHAPE" is applied to sections of relatively complex shape, produced by extrusion and straightening only, where it is impossible or impractical to cold draw.

"TUBE" is applied to any hollow section regardless of shape.

Certain shapes formed by drawing through dies from strip are known as "drawn shapes" but sometimes as "open seam" tubes.

SIZE

In general, the length of any product regardless of form is specified in inches and fractions or in feet, inches and fractions. Width of plate, sheet and strip is also almost invariably specified in inches and fractions of inches. In the narrower strips decimals are sometimes used and are proper. Diameter of round and size of hexagonal and other simple shapes of rod and the diameter of ordinary tubes are also normally specified in terms of inches and fractions.

Gauge systems are quite generally used for indicating thickness of plate sheet and strip, wall thickness of tube and diameter of wire. The system most commonly applied to thickness of sheet and to diameter of wire is the Brown & Sharpe system and that applied to wall thickness of tubes is the Birmingham or Stubs system. While these gauge numbers are still considerably so used, decimals are considered preferable and are strongly recommended. Where gauge numbers are used it should be definitely stated what gauge system is involved and the gauge number should invariably be followed by the equivalent decimal in parentheses, as for instance, No. 22 B&S (0.025").

For large plates and frequently for other forms weight is more important than actual dimensions and a weight per piece or per unit of length or of area is used in place of linear dimensions. This is quite proper, but it should be clearly stated so that no confusion results.

TOLERANCES

It is physically impossible to produce metal sections of precisely the dimensions desired so that a reasonable tolerance or variation from the nominal is customarily allowed. In the great majority of cases the commercial tolerance which has been found over a period of years to represent good mill procedure is all that is necessary. Such tables of commercial tolerances are given in tables on pages 52, 53, 54 and 55 of this book. Where for any reason it appears essential to have a lesser variation than indicated by the standard tables, such narrower tolerance frequently can be adhered to but this should be clearly stated and understood at the time of placing of the order. Such closer-than-commercial tolerances will as a rule call for a price extra.

TEMPERS

(a) Plate, Sheet, Strip and Wire Tempers.

Annealed tempers are preferably specified in terms of grain size for all alloys having largely or entirely an alpha structure, which comprise the great majority of all listed in this book. Other terms have to be applied to such alloys as are not substantially all alpha structure. The standard annealed tempers for sheet, strip and wire are shown below.

Standard Tempers	Approximate Equivalent Terminology (Applied to Alloys Not of All-Alpha Structure)
0.018 mm.	....
0.025 mm.	Light Anneal
0.035 mm.	....
0.050 mm.	Intermediate Anneal
0.070 mm.	Soft Anneal
0.100 mm.	Dead Soft Anneal

The tempers produced in plate, sheet and strip by final rolling, and in wire by final drawing, are as follows:

Standard Temper Designation	Reduction in B&S Gauge Numbers	Plate, Sheet, and Strip: % Reduction in Thickness	Wire: % Reduction in Area
1/8 Hard	1/2	6	11
1/4 Hard	1	11	21
1/2 Hard	2	21	37
3/4 Hard	3	29	50
Hard	4	37	60
Extra Hard	6	50	75
Spring	8	60	84
Extra Spring	10	68	90

In a very few instances tempers much harder than those indicated in the above table, are used in which event they are invariably specified in terms of B&S Nos. hard, as for instance, 12 Nos. hard, which would be equivalent to 75% reduction in sheet or strip, and to 94% reduction in wire.

In addition to the tempers listed in the foregoing tables, Olympic Bronze is also supplied in "hot rolled" temper for tank fabrication purposes. This temper is that normally resulting from hot rolling to final gage without subsequent treatment.

(b) Rod Tempers
(Alloys other than Olympic Bronze)

ANNEALED — Corresponds approximately with 0.035 mm. annealed sheet. This temper is rather infrequently required.

QUARTER HARD—A final reduction of about 6 to 12% depending upon size.

DRILL TEMPER—A final reduction of about 20 to 25% depending on size. This temper is the one most used.

EXTRA HARD—Any temper harder than drill temper.

(c) Rod Tempers. (Olympic Bronze)

LIGHT ANNEAL—Approximately .025 mm. grain size. (Used very little.)

SOFT ANNEAL—Approximately .050 mm. grain size. (Used very little.)

HALF HARD—About 20% reduction by drawing.

HARD—About 35% reduction by drawing.

EXTRA HARD—About 50% reduction by drawing.

(d) Tube Tempers.

Annealed tube tempers are indicated by grain size the same as for sheet and strip. Drawn tempers are as follows:

QUARTER HARD—A reduction of from about 10 to 15%.

HALF HARD—A reduction of from about 20 to 30%.

HARD—A reduction of more than 35%.

FINISHES

"ROLLED FINISH" on plate, sheet or strip is that produced when the final operation has been cold rolling.

"DRY ROLLED FINISH" on sheet or strip is produced by giving the final rolling without the use of any metal lubricant. It gives a burnished, lustrous surface and is applied only to finished tempers of about ½ to 2 B & S numbers hard.

"KEROSENE ROLLED FINISH" is quite similar to but not quite as bright as "dry rolled finish." It is produced by using kerosene on the final passes instead of metal oil.

"DRAWN FINISH" refers to rod, wire or tube and is that normally produced when the final reduction is by drawing through a die.

"PISTON FINISH" on rod signifies not only a superior quality of surface texture produced by grinding or turning, but also close tolerances and a nearer approach to absolute straightness than found on commercial rod.

"OXIDIZED FINISH" applies to any material annealed as a final operation and where subsequent pickling or dipping is not resorted to. Ordinarily annealed materials are "pickled," usually in a solution of sulphuric acid which removes oxide formed by annealing.

"SODA DIP" or "BICHROMATE DIP FINISH" is a fairly bright finish produced by dipping in a solution of sodium bichromate and sulphuric acid in water following the ordinary pickle.

"BRIGHT DIP FINISH" is, strictly speaking, applied only to dips composed of strong acids (as for instance a solution of sulphuric and nitric acids in water) which remove all traces of oxide and leave the surface with a slightly etched appearance where the resultant color is the true one for the alloy involved.

"BRIGHT ANNEALED FINISH" is a term applied to material annealed in such an atmosphere that no oxide or scale of any description can form and the metal surface comes from the furnace as clean and bright as before annealing.

MISCELLANEOUS TABLES

WEIGHT TABLES

On the following pages will be found certain tables covering theoretical weights of some of the most used alloys. These tables have been carefully prepared and we feel are an improvement over similar tables previously used in the industry. To get the weights of other alloys, corrections can be made according to the ratios of the densities shown in the tables on previous pages.

TOLERANCE TABLES

There are also tables of standard tolerances to which our alloys are invariably made in the absence of any other instructions. For practically all commercial applications these tolerances will be found entirely adequate. While narrower tolerances can in certain cases be met, such should not be specified unless there is some real benefit and where this benefit is worth the extra charge usually necessary.

MISCELLANEOUS TABLES

There is also a table showing the decimal equivalents for various standard gage systems and another of decimal equivalents of fractions of inches.

Pounds Per Lineal Foot*

Gage		1/16"		3/32"		1/8"		5/32"		3/16"		7/32"	
B. & S.	Dec.	Brass	Copper	Brass	Copper	Brass	Copper	Brass	Copper	Brass	Copper	Brass	Copper
1	.289	..	..	..	..	..	..	..	..	..	..	..	..
2	.258	..	..	..	..	..	..	..	..	..	..	..	..
3	.229	..	..	..	..	..	..	..	..	..	..	.184	.194
4	.204	..	..	..	..	..	..	..	..	..	..	.164	.173
5	.182	..	..	..	..	..	..	..	..	.126	.132	.147	.154
6	.162	..	..	..	..	..	..	.093	.098	.112	.118	.131	.137
7	.144	..	..	..	..	..	..	.083	.087	.0995	.105	.116	.122
8	.128	..	..	..	..	.059	.061	.074	.076	.0884	.092	.103	.107
9	.114	..	..	..	..	.0525	.052	.0656	.069	.079	.083	.092	.097
10	.102	..	..	..	..	.0470	.0494	.0587	.062	.0705	.074	.082	.086
11	.091	..	..	.0314	.0331	.0419	.0441	.0524	.055	.063	.066	.073	.077
12	.081	..	..	.0280	.0294	.0373	.0392	.0466	.049	.056	.059	.065	.069
13	.072	..	..	.0249	.0262	.0332	.0349	.0414	.0436	.0497	.0523	.058	.061
14	.064	.0147	.0155	.0221	.0233	.0295	.0310	.0368	.0388	.0442	.0465	.0516	.0543
15	.057	.0131	.0138	.0197	.0206	.0262	.0276	.0328	.0345	.0394	.0414	.0459	.0483
16	.051	.0117	.0124	.0176	.0185	.0235	.0247	.0294	.0309	.0352	.0371	.0411	.0432
17	.045	.0104	.0109	.0155	.0164	.0207	.0218	.0259	.0273	.0311	.0327	.0363	.0382
18	.0403	.0093	.0098	.0139	.0146	.0186	.0195	.0232	.0244	.0278	.0293	.0325	.0342
19	.0359	.0083	.0087	.0124	.0130	.0165	.0174	.0207	.0217	.0248	.0261	.0289	.0304
20	.0320	.0074	.0077	.0110	.0116	.0147	.0155	.0184	.0194	.0221	.0233	.0258	.0271
21	.0285	.0066	.0069	.0098	.0104	.0131	.0138	.0164	.0173	.0197	.0207	.0230	.0242
22	.0253	.00583	.00613	.0087	.0092	.0116	.0123	.0146	.0153	.0175	.0184	.0204	.0214
23	.0226	.00520	.00547	.0078	.0082	.0104	.0110	.0130	.0137	.0156	.0164	.0182	.0192
24	.0201	.00463	.00487	.00694	.0073	.0093	.0097	.0116	.0122	.0139	.0146	.0162	.0170
25	.0179	.00412	.00434	.0062	.0065	.0082	.0087	.0103	.0108	.0124	.0130	.0144	.0152
26	.0159	.00366	.00385	.0055	.0058	.0073	.0077	.00915	.0096	.0110	.0116	.0128	.0135
27	.0142	.00327	.00344	.0049	.00516	.00654	.00688	.00817	.0086	.0098	.0103	.0144	.0120
28	.0126	.00290	.00305	.00435	.00458	.00580	.00610	.00725	.0076	.0087	.0092	.0101	.0107
29	.0113	.00260	.00274	.00390	.00411	.00520	.00547	.00650	.00684	.0078	.0082	.0091	.0096
30	.0100	.00230	.00242	.00345	.00364	.00461	.00485	.00576	.00606	.0069	.0073	.0081	.0085
31	.0089	.00205	.00216	.00307	.00323	.00410	.00431	.00512	.00539	.00615	.0065	.0072	.0075
32	.0080	.00184	.00194	.00276	.00291	.00368	.00388	.00461	.00485	.00553	.0058	.0064	.0068
33	.0071	.00163	.00172	.00245	.00258	.00327	.00344	.00409	.00430	.00490	.00516	.0057	.0060
34	.0063	.00145	.00153	.00218	.00229	.00290	.00305	.00363	.00382	.00435	.00458	.0051	.00534
35	.0056	.00129	.00136	.00193	.00203	.00258	.00271	.00322	.00339	.00387	.00407	.0045	.00475
36	.0050	.00115	.00121	.00173	.00182	.00230	.00242	.00288	.00303	.00345	.00363	.00403	.00424
37	.0045	.00104	.00109	.00155	.00163	.00207	.00218	.00259	.00272	.00311	.00327	.00363	.00382
38	.0040	.00092	.00097	.00138	.00145	.00184	.00194	.00230	.00242	.00276	.00291	.00322	.00339
39	.0035	.00081	.00085	.00121	.00127	.00161	.00170	.00201	.00212	.00242	.00254	.00282	.00297
40	.0031	.000714	.000751	.00107	.00113	.00143	.00150	.00178	.00188	.00214	.00225	.00250	.00263

* Based on densities of 0.307 pounds per cubic inch for Eyelet Brass and 0.323 pounds per cubic inch for Copper respectively.

Continued on Page 41

WEIGHTS OF BRASS AND COPPER SHEET AND STRIP

Pounds Per Lineal Foot*

Gage		1/4″		5/16″		3/8″		1/2″		5/8″		3/4″	
B. & S.	Dec.	Brass	Copper	Brass	Copper	Brass	Copper	Brass	Copper	Brass	Copper	Brass	Copper
1	.289	.266	.280	.333	.350	.399	.420	.532	.560	.665	.700	.799	.840
2	.258	.238	.250	.297	.313	.356	.375	.475	.500	.594	.625	.713	.750
3	.229	.211	.222	.264	.277	.316	.333	.422	.444	.527	.555	.633	.666
4	.204	.188	.198	.235	.247	.282	.297	.376	.395	.470	.494	.564	.593
5	.182	.168	.176	.209	.220	.251	.265	.335	.353	.419	.441	.503	.529
6	.162	.149	.157	.186	.196	.224	.235	.298	.314	.373	.392	.448	.471
7	.144	.133	.139	.166	.174	.199	.209	.265	.279	.332	.349	.398	.419
8	.128	.118	.122	.147	.153	.177	.183	.236	.244	.295	.305	.354	.366
9	.114	.105	.110	.131	.138	.157	.166	.210	.221	.262	.276	.315	.331
10	.102	.094	.099	.117	.124	.141	.148	.188	.198	.235	.247	.282	.296
11	.091	.084	.088	.105	.110	.126	.132	.168	.176	.209	.220	.251	.264
12	.081	.075	.078	.093	.098	.112	.118	.149	.157	.186	.196	.224	.235
13	.072	.066	.070	.083	.087	.099	.105	.133	.139	.166	.174	.199	.209
14	.064	.058	.062	.074	.077	.088	.093	.118	.124	.147	.155	.177	.186
15	.057	.0525	.055	.0656	.0690	.079	.083	.105	.110	.131	.138	.157	.166
16	.051	.0470	.0494	.0587	.0618	.0705	.0741	.094	.099	.117	.123	.141	.148
17	.045	.0415	.0436	.0518	.0545	.0622	.0654	.083	.087	.104	.109	.124	.131
18	.0403	.0371	.0391	.0464	.0488	.0557	.0586	.074	.078	.093	.098	.111	.117
19	.0359	.0331	.0348	.0413	.0435	.0496	.0522	.0661	.0696	.083	.087	.099	.104
20	.0320	.0295	.0310	.0368	.0388	.0442	.0465	.0589	.0620	.074	.077	.088	.093
21	.0285	.0262	.0276	.0328	.0345	.0394	.0414	.0525	.0552	.0656	.0690	.079	.083
22	.0253	.0233	.0245	.0291	.0306	.0350	.0368	.0466	.0490	.0583	.0613	.0699	.0735
23	.0226	.0208	.0219	.0260	.0274	.0312	.0329	.0416	.0438	.0520	.0547	.0624	.0657
24	.0201	.0185	.0195	.0231	.0243	.0278	.0292	.0370	.0390	.0463	.0487	.0555	.0584
25	.0179	.0165	.0173	.0206	.0217	.0247	.0260	.0330	.0347	.0412	.0434	.0495	.0520
26	.0159	.0146	.0154	.0183	.0193	.0220	.0231	.0293	.0308	.0366	.0385	.0439	.0462
27	.0142	.0131	.0138	.0163	.0172	.0196	.0206	.0262	.0275	.0327	.0344	.0392	.0413
28	.0126	.0116	.0122	.0145	.0153	.0174	.0183	.0232	.0244	.0290	.0305	.0348	.0366
29	.0113	.0104	.0109	.0130	.0137	.0156	.0164	.0208	.0219	.0260	.0274	.0312	.0329
30	.0100	.0092	.0097	.0115	.0121	.0138	.0145	.0184	.0194	.0230	.0242	.0276	.0291
31	.0089	.0082	.0086	.0102	.0108	.0123	.0129	.0164	.0172	.0205	.0216	.0246	.0259
32	.0080	.0038	.0077	.0092	.0097	.0110	.0116	.0147	.0155	.0184	.0194	.0221	.0233
33	.0071	.0065	.0069	.0082	.0086	.0098	.0103	.0131	.0137	.0163	.0172	.0196	.0206
34	.0063	.0058	.0061	.0072	.0076	.0087	.0092	.0111	.0122	.0145	.0153	.0174	.0183
35	.0056	.0052	.0054	.0064	.0068	.0077	.0081	.0103	.0108	.0129	.0136	.0154	.0163
36	.0050	.0046	.0048	.0058	.0061	.0069	.0073	.0092	.0097	.0115	.0121	.0138	.0154
37	.0045	.0041	.0044	.0052	.0054	.0062	.0065	.0083	.0087	.0104	.0109	.0124	.0131
38	.0040	.0037	.0039	.0046	.00485	.0055	.0058	.0074	.0077	.0092	.0097	.0110	.0116
39	.0035	.0032	.0034	.00403	.00424	.00484	.0051	.00645	.00678	.00806	.00848	.0097	.0102
40	.0031	.00285	.00300	.00357	.00375	.00428	.0045	.00511	.00601	.00714	.00751	.0086	.0090

* Based on densities of 0.307 pounds per cubic inch for Eyelet Brass and 0.323 pounds per cubic inch for Copper respectively.

Continued on Page 42

WEIGHTS OF BRASS AND COPPER SHEET AND STRIP

Pounds Per Lineal Foot*

Gage		1″		2″		3″		4″		5″		6″	
B. & S.	Dec.	Brass	Copper	Brass	Copper	Brass	Copper	Brass	Copper	Brass	Copper	Brass	Copper
1	.289	1.065	1.120	2.13	2.24	3.19	3.36	4.26	4.48	5.32	5.60	6.39	6.72
2	.258	.950	1.100	1.90	2.00	2.85	3.00	3.80	4.00	4.75	5.00	5.70	6.00
3	.229	.885	.888	1.69	1.77	2.65	2.66	3.54	3.55	4.42	4.44	5.31	5.33
4	.204	.788	.791	1.52	1.58	2.36	2.37	3.15	3.16	3.94	3.95	4.73	4.74
5	.182	.670	.705	1.35	1.41	2.03	2.12	2.71	2.82	3.38	3.53	4.06	4.23
6	.162	.597	.628	1.19	1.26	1.79	1.88	2.39	2.51	2.98	3.14	3.58	3.77
7	.144	.530	.558	1.06	1.12	1.59	1.67	2.12	2.23	2.65	2.79	3.18	3.35
8	.128	.472	.488	.943	.977	1.41	1.46	1.88	1.95	2.36	2.44	2.83	2.93
9	.114	.420	.442	.840	.884	1.26	1.33	1.68	1.77	2.10	2.21	2.52	2.65
10	.102	.376	.395	.752	.791	1.13	1.19	1.50	1.58	1.88	1.98	2.25	2.37
11	.091	.335	.353	.670	.705	1.00	1.06	1.34	1.41	1.68	1.76	2.01	2.12
12	.081	.298	.314	.597	.628	.895	.942	1.19	1.26	1.49	1.57	1.79	1.88
13	.072	.265	.279	.530	.558	.796	.837	1.06	1.12	1.33	1.39	1.59	1.67
14	.064	.236	.248	.472	.496	.707	.744	.943	.992	1.18	1.24	1.41	1.49
15	.057	.210	.221	.420	.442	.630	.663	.840	.884	1.05	1.10	1.26	1.33
16	.051	.188	.198	.376	.395	.564	.593	.752	.791	.939	.988	1.13	1.19
17	.045	.166	.174	.332	.349	.497	.523	.663	.698	.829	.872	.995	1.03
18	.0403	.148	.156	.297	.312	.445	.469	.594	.625	.742	.781	.891	.937
19	.0359	.132	.139	.264	.278	.397	.418	.529	.557	.661	.696	.794	.835
20	.0320	.118	.124	.236	.248	.354	.372	.472	.496	.589	.620	.707	.744
21	.0285	.105	.110	.210	.221	.315	.331	.420	.442	.525	.552	.630	.663
22	.0253	.093	.098	.186	.196	.280	.294	.373	.392	.466	.490	.559	.588
23	.0226	.083	.088	.166	.175	.250	.263	.333	.350	.416	.438	.500	.526
24	.0201	.074	.078	.148	.156	.222	.234	.296	.312	.370	.390	.444	.468
25	.0179	.066	.0694	.132	.139	.198	.208	.264	.277	.330	.347	.396	.416
26	.0159	.0586	.0616	.117	.123	.176	.185	.234	.246	.293	.308	.351	.370
27	.0142	.0513	.0550	.103	.110	.154	.165	.205	.220	.257	.275	.308	.330
28	.0126	.0464	.0488	.093	.098	.139	.146	.186	.195	.232	.244	.278	.293
29	.0113	.0416	.0438	.083	.088	.125	.131	.166	.175	.208	.219	.250	.263
30	.0100	.0368	.0388	.074	.0775	.110	.116	.147	.155	.184	.194	.221	.233
31	.0089	.0328	.0345	.0656	.0690	.098	.103	.131	.138	.164	.172	.197	.207
32	.0080	.0295	.0310	.0589	.0620	.088	.093	.118	.124	.147	.155	.177	.186
33	.0071	.0262	.0275	.0523	.0550	.078	.083	.105	.110	.131	.137	.157	.165
34	.0063	.0232	.0244	.0464	.0488	.070	.073	.093	.098	.116	.122	.139	.146
35	.0056	.0206	.0217	.0413	.0434	.062	.065	.082	.087	.103	.108	.124	.130
36	.0050	.0184	.0194	.0386	.0388	.055	.058	.074	.077	.092	.097	.110	.116
37	.0045	.0166	.0174	.0332	.0349	.050	.052	.066	.070	.083	.087	.099	.105
38	.0040	.0147	.0155	.0295	.0310	.044	.046	.059	.062	.074	.077	.088	.093
39	.0035	.0129	.0136	.0258	.0271	.039	.041	.0516	.0543	.0645	.068	.0774	.081
40	.0031	.0114	.0120	.0228	.0343	.034	.036	.0457	.0481	.0571	.060	.0685	.072

* Based on densities of 0.307 pounds per cubic inch for Eyelet Brass and 0.323 pounds per cubic inch for Copper respectively.

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CHASE

WEIGHTS OF BRASS AND COPPER SHEET AND STRIP

Pounds Per Lineal Foot*

Gage		7″		8″		9″		10″		11″		12″	
B. & S.	Dec.	Brass	Copper	Brass	Copper	Brass	Copper	Brass	Copper	Brass	Copper	Brass	Copper
1	.289	7.45	7.84	8.52	8.96	9.58	10.1	10.65	11.20	11.71	12.32	12.75	13.44
2	.258	6.65	7.00	7.60	8.00	8.55	9.00	9.50	10.00	10.45	11.00	11.35	12.00
3	.229	6.19	6.21	7.08	7.10	7.96	7.99	8.85	8.88	9.73	9.77	10.11	10.66
4	.204	5.52	5.54	6.31	6.33	7.09	7.12	7.88	7.91	8.67	8.69	9.00	9.48
5	.182	4.74	4.94	5.41	5.64	6.09	6.35	6.70	7.05	7.37	7.76	8.02	8.46
6	.162	4.18	4.40	4.77	5.02	5.37	5.65	5.97	6.28	6.56	6.91	7.14	7.54
7	.144	3.71	3.91	4.24	4.47	4.77	5.02	5.30	5.58	5.83	6.14	6.36	6.70
8	.128	3.30	3.42	3.77	3.91	4.24	4.40	4.72	4.88	5.19	5.37	5.66	5.86
9	.114	2.94	3.09	3.36	3.54	3.78	3.98	4.20	4.42	4.62	4.86	5.04	5.30
10	.102	2.63	2.77	3.01	3.16	3.38	3.56	3.76	3.95	4.13	4.35	4.49	4.74
11	.091	2.35	2.47	2.68	2.82	3.02	3.17	3.35	3.53	3.69	3.88	4.00	4.23
12	.081	2.09	2.20	2.39	2.51	2.69	2.83	2.98	3.14	3.28	3.45	3.56	3.77
13	.072	1.86	1.95	2.12	2.23	2.39	2.51	2.65	2.79	2.92	3.07	3.17	3.35
14	.064	1.65	1.74	1.88	1.98	2.12	2.23	2.36	2.48	2.59	2.73	2.82	2.98
15	.057	1.47	1.55	1.68	1.77	1.89	1.99	2.10	2.21	2.31	2.43	2.51	2.65
16	.051	1.31	1.38	1.50	1.58	1.69	1.78	1.88	1.98	2.07	2.17	2.24	2.37
17	.045	1.16	1.22	1.33	1.39	1.49	1.57	1.66	1.74	1.82	1.92	1.99	2.09
18	.0403	1.04	1.09	1.19	1.25	1.34	1.41	1.48	1.56	1.63	1.72	1.78	1.87
19	.0359	.926	.974	1.06	1.11	1.19	1.25	1.32	1.39	1.45	1.53	1.58	1.67
20	.0320	.825	.868	.943	.992	1.06	1.12	1.18	1.24	1.30	1.36	1.41	1.49
21	.0285	.735	.773	.840	.884	.945	.994	1.05	1.10	1.15	1.21	1.25	1.33
22	.0253	.652	.686	.746	.785	.839	.883	.932	.981	1.02	1.08	1.12	1.18
23	.0226	.583	.613	.666	.701	.749	.788	.833	.876	.916	.964	.995	1.05
24	.0201	.518	.545	.592	.623	.666	.701	.740	.779	.814	.857	.886	.936
25	.0179	.462	.486	.528	.555	.593	.624	.659	.694	.725	.763	.789	.832
26	.0159	.410	.431	.469	.493	.527	.555	.586	.616	.644	.678	.702	.740
27	.0142	.359	.385	.411	.440	.462	.495	.513	.550	.565	.605	.625	.660
28	.0126	.325	.342	.371	.391	.418	.440	.464	.488	.511	.537	.557	.586
29	.0113	.291	.307	.333	.350	.375	.394	.416	.438	.458	.482	.496	.526
30	.0100	.258	.271	.295	.310	.332	.349	.368	.388	.405	.426	.442	.465
31	.0089	.229	.241	.262	.276	.295	.311	.328	.345	.361	.379	.393	.414
32	.0080	.206	.217	.236	.248	.265	.279	.295	.310	.324	.341	.350	.372
33	.0071	.183	.193	.209	.220	.235	.248	.262	.274	.288	.302	.312	.330
34	.0063	.162	.171	.186	.195	.209	.220	.232	.244	.255	.269	.278	.293
35	.0056	.144	.152	.165	.174	.186	.195	.206	.217	.227	.239	.247	.260
36	.0050	.129	.136	.147	.155	.166	.174	.184	.194	.203	.213	.220	.233
37	.0045	.116	.122	.133	.139	.149	.157	.166	.174	.182	.192	.196	.209
38	.0040	.103	.108	.118	.124	.133	.139	.147	.155	.162	.170	.175	.186
39	.0035	.090	.095	.103	.108	.116	.122	.129	.136	.142	.149	.156	.163
40	.0031	.080	.084	.091	.096	.103	.108	.114	.120	.126	.132	.139	.144

* Based on densities of 0.307 pounds per cubic inch for Eyelet Brass and 0.323 pounds per cubic inch for Copper respectively

WEIGHTS OF RODS

Pounds Per Lineal Foot*

Diam. Inches	FREE CUTTING BRASS			OLYMPIC BRONZE TYPES A & B			FREE CUTTING COMMERCIAL BRONZE		
	Round	Square	Hexagon	Round	Square	Hexagon	Round	Square	Hexagon
1/32	.00282	..	..	.00285	..	..	.00294	..	..
1/16	.00113	.0144	.0124	.0114	.0145	.0125	.0118	.0150	.0130
3/32	.0254	..	..	.0257	..	..	.0265	..	..
1/8	.0453	.0578	.0501	.0458	.0584	.0506	.0472	.0603	.0523
5/32	.0704	..	..	.0710	..	..	.0734	..	..
3/16	.102	.130	.113	.103	.131	.114	.106	.136	.118
7/32	.138	..	..	.140	..	..	.144	..	..
1/4	.180	.230	.199	.182	.232	.201	.188	.240	.208
9/32	.228	..	..	.230	..	..	.238	..	..
5/16	.283	.361	.312	.286	.364	.315	.295	.376	.325
11/32	.342	..	..	.345	..	..	.357	..	..
3/8	.407	.518	.45	.41	.523	.453	.424	.540	.467
13/32	.477	..	..	.48	..	..	.497	..	..
7/16	.553	.706	.61	.563	.713	.617	.58	.736	.637
15/32	.637	..	..	.64	..	..	.66	..	..
1/2	.724	.922	.799	.73	.93	.806	.754	.96	.832
17/32	.816	..	..	.824	..	..	.85	..	..
9/16	.92	1.17	1.00	.93	1.18	1.02	.96	1.21	1.05
19/32	1.02	..	..	1.03	..	..	1.06	..	..
5/8	1.13	1.44	1.24	1.14	1.45	1.26	1.18	1.50	1.30
21/32	1.24	..	..	1.26	..	..	1.30	..	..
11/16	1.37	1.74	1.51	1.38	1.76	1.52	1.43	1.82	1.57
23/32	1.49	..	..	1.51	..	..	1.56	..	..
3/4	1.62	2.07	1.79	1.64	2.09	1.81	1.69	2.16	1.87
25/32	1.76	..	..	1.78	..	..	1.84	..	..
13/16	1.91	2.44	2.1	1.93	2.46	2.13	1.99	2.54	2.20
27/32	2.06	..	..	2.08	..	..	2.15	..	..
7/8	2.2	2.82	2.44	2.23	2.85	2.46	2.30	2.94	2.54
29/32	2.37	..	..	2.40	..	..	2.47	..	..
15/16	2.54	3.24	2.80	2.57	3.27	2.83	2.65	3.37	2.92
31/32	2.7	..	..	2.74	..	..	2.83	..	..
1	2.9	3.7	3.2	2.92	3.72	3.22	3.0	3.84	3.32
1 1/16	3.26	4.16	3.60	3.3	4.2	3.64	3.4	4.34	3.76
1 1/8	3.65	4.66	4.04	3.7	4.7	4.08	3.8	4.8	4.2

* Based on densities of 0.308, 0.310, and 0.320 pounds per cubic inch for Free Cutting Brass, Olympic Bronze, and Free Cutting Commercial Bronze respectively.

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Pounds Per Lineal Foot*

Diam. Inches	FREE CUTTING BRASS			OLYMPIC BRONZE TYPES A & B			FREE CUTTING COMMERCIAL BRONZE		
	Round	Square	Hexagon	Round	Square	Hexagon	Round	Square	Hexagon
1 3/16	4.07	5.2	4.5	4.12	5.26	4.55	4.26	5.43	4.7
1 1/4	4.5	5.76	5.0	4.56	5.8	5.03	4.7	6.0	5.2
1 5/16	5.0	6.35	5.5	5.03	6.4	5.56	5.2	6.6	5.73
1 3/8	5.46	7.0	6.04	5.5	7.04	6.1	5.7	7.27	6.3
1 7/16	6.0	7.63	6.6	6.04	7.7	6.7	6.23	7.96	6.9
1 1/2	6.5	8.3	7.2	6.57	8.4	7.25	6.8	8.65	7.5
1 9/16	7.05	9.0	7.8	7.1	9.1	7.9	7.35	9.4	8.13
1 5/8	7.6	9.74	8.4	7.7	9.8	8.5	7.95	10.1	8.8
1 11/16	8.2	10.5	9.1	8.3	10.6	9.2	8.6	11.0	9.5
1 3/4	8.85	11.3	9.8	8.9	11.4	9.9	9.2	11.8	10.2
1 13/16	9.5	12.1	10.5	9.6	12.2	10.6	9.9	12.6	10.9
1 7/8	10.1	12.9	11.2	10.2	13.1	11.3	10.6	13.5	11.7
1 15/16	10.9	13.8	12.0	11.0	14.0	12.1	11.3	14.4	12.5
2	11.6	14.7	12.7	11.7	14.9	12.9	12.1	15.3	13.3
2 1/8	13.1	16.6	14.4	13.2	16.8	14.5	13.6	17.3	15.0
2 1/4	14.6	18.6	16.1	14.8	18.8	16.3	15.3	19.4	16.8
2 3/8	16.3	20.8	18.0	16.5	21.0	18.2	17.0	21.7	18.8
2 1/2	18.1	23.0	19.9	18.3	23.3	20.1	18.8	24.0	20.8
2 5/8	19.9	25.4	22.0	20.0	25.6	22.2	20.8	26.4	23.0
2 3/4	21.9	28.0	24.1	22.0	28.0	24.4	22.8	29.0	25.0
2 7/8	24.0	30.5	26.4	24.0	30.8	26.6	25.0	31.7	27.5
3	26.0	33.1	28.7	26.3	33.5	29.0	27.0	34.6	30.0
3 1/4	30.5	39.0	33.7	30.8	39.3	34.0	31.8	40.5	35.0
3 1/2	35.4	45.0	39.0	35.8	45.6	39.5	37.0	47.0	40.8
3 3/4	40.7	52.0	45.0	41.0	52.4	45.3	42.4	54.1	46.8
4	46.1	59.0	51.0	46.7	59.5	51.6	48.2	61.5	53.2
4 1/4	52.3	66.6	57.7	52.8	67.0	58.0	54.5	69.4	60.0
4 1/2	58.6	74.6	64.7	59.0	75.4	65.0	61.0	78.0	67.4
4 3/4	65.0	83.0	72.0	66.0	84.0	72.6	68.0	86.7	75.0
5	72.3	92.0	80.0	73.0	93.0	80.6	75.4	96.0	83.2
5 1/4	79.7	101.	88.0	80.5	102.	89.0	83.0	106.	92.0
5 1/2	87.0	111.	96.5	88.0	112.	97.5	91.0	116.	100.
5 3/4	95.6	122.	105.	96.6	123.	106.	100.	127.	110.
6	104.	133.	115.	105.	134.	116.	108.	138.	120.

* Based on densities of 0.308, 0.310, and 0.320 pounds per cubic inch for Free Cutting Brass, Olympic Bronze, and Free Cutting Commercial Bronze respectively.

WEIGHTS OF WIRES

Pounds per 1000 feet and feet per pound.*

B. & S. Gage No.	High Brass		Copper		18% Nickel Silver		Olympic Bronze		5% Phos. Bronze	
	Wt. Per 1,000 Ft.	Feet Per Lb.	Wt. Per 1,000 Ft.	Feet Per Lb.	Wt. Per 1,000 Ft.	Feet Per Lb.	Wt. Per 1,000 Ft.	Feet Per Lb.	Wt. Per 1,000 Ft.	Feet Per Lb.
1	241.	4.15	254.	3.94	247.	4.04	244.	4.1	252.	3.97
2	192.	5.2	202.	5.0	196.	5.1	194.	5.17	200.	5.0
3	152.	6.6	160.	6.25	155.	6.44	154.	6.5	159.	6.3
4	121.	8.3	127.	7.9	123.	8.1	122.	8.2	126.	7.95
5	96.	10.3	101.	9.95	98.	10.2	97.	10.4	100.	10.0
6	76.	13.2	80.	12.5	77.6	12.9	77.	13.0	79.	12.6
7	60.3	16.6	63.4	15.8	61.5	16.2	61.	16.4	63.	15.9
8	48.	20.9	50.	19.9	48.8	20.5	48.3	20.7	49.8	20.0
9	37.8	26.4	39.7	25.2	38.7	25.8	38.2	26.2	39.4	25.4
10	30.1	33.3	31.6	31.6	30.7	32.6	30.4	32.7	31.3	31.9
11	23.8	42.1	25.0	40.0	24.3	41.1	24.0	41.7	24.8	40.4
12	18.9	53.0	19.9	50.2	19.3	51.8	19.1	52.5	19.7	51.0
13	14.9	67.0	15.7	63.7	15.3	65.3	15.1	66.4	15.6	64.3
14	11.9	84.2	12.5	80.0	12.1	82.3	12.0	83.4	12.4	81.0
15	9.4	106.	9.9	101.	9.6	104.	9.5	105.	9.85	101.
16	7.2	138.	7.6	131.	7.6	131.	7.3	137.	7.55	133.
17	5.9	170.	6.2	162.	6.05	165.	5.94	168.	6.1	163.
18	4.7	213.	4.95	202.	4.8	208.	4.75	211.	4.9	204.
19	3.7	269.	3.9	256.	3.8	263.	3.76	266.	3.88	258.
20	2.95	339.	3.1	322.	3.02	331.	2.98	336.	3.08	325.
21	2.34	428.	2.46	407.	2.40	417.	2.36	424.	2.44	410.
22	1.86	539.	1.95	513.	1.90	526.	1.87	534.	1.94	518.
23	1.47	680.	1.55	646.	1.51	664.	1.49	673.	1.53	652.
24	1.17	857.	1.23	815.	1.19	837.	1.18	849.	1.22	823.
25	0.93	1,080.	0.975	1,030.	0.95	1,060.	0.94	1,070.	0.97	1,040.
26	0.735	1,360.	0.77	1,290.	0.75	1,330.	0.74	1,350.	0.77	1,310.
27	0.583	1,720.	0.614	1,630.	0.595	1,680.	0.54	1,860.	0.61	1,650.
28	0.465	2,150.	0.487	2,055.	0.47	2,120.	0.47	2,145.	0.48	2,075.
29	0.367	2,730.	0.386	2,595.	0.374	2,670.	0.37	2,700.	0.38	2,615.
30	0.29	3,450.	0.306	3,275.	0.297	3,370.	0.29	3,415.	0.30	3,305.
31	0.23	4,345.	0.242	4,130.	0.236	4,245.	0.233	4,300.	0.240	4,170.
32	0.183	5,480.	0.192	5,210.	0.187	5,350.	0.184	5,430.	0.190	5,260.
33	0.145	6,910.	0.152	6,570.	0.148	6,750.	0.146	6,845.	0.151	6,630.
34	0.115	8,710.	0.121	8,770.	0.117	8,510.	0.116	8,620.	0.120	8,850.
35	0.091	10,970.	0.096	10,430.	0.093	10,730.	0.092	10,870.	0.095	10,530.
36	0.072	13,840.	0.075	13,250.	0.074	13,530.	0.073	13,710.	0.075	13,280.

* Based on densities of 0.307, 0.323 and 0.316 pounds per cubic inch for Brass, Copper and Nickel Silver respectively.

WEIGHTS OF BRASS AND COPPER TUBE

Pounds Per Lineal Foot*

Stubs Gage		4		5		6		7		8		9	
Dec. Equiv.		0.238		0.220		0.203		0.180		0.165		0.148	
Nearest Fraction		15/64		7/32		13/64		3/16		11/64		9/64	
O.D. in In.		Brass	Copper	Brass	Copper	Brass	Copper	Brass	Copper	Brass	Copper	Brass	Copper
	1/8	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
	1/4	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
	3/8	. .	. .	. .	. .	. .	. .	. .	. .	.401	.421	.390	.408
	1/2	. .	. .	. .	. .	.698	.733	.666	.700	.640	.672	.603	.633
	5/8	1.07	1.12	1.03	1.08	.991	1.04	.930	.974	.880	.923	.820	.860
	3/4	1.41	1.48	1.35	1.42	1.28	1.35	1.19	1.25	1.12	1.17	1.03	1.08
	7/8	1.75	1.84	1.67	1.75	1.58	1.66	1.45	1.52	1.35	1.42	1.24	1.31
1		2.10	2.21	1.99	2.09	1.87	1.97	1.71	1.79	1.59	1.68	1.46	1.53
	1/8	2.44	2.57	2.30	2.42	2.17	2.28	1.97	2.07	1.83	1.93	1.67	1.76
	1/4	2.79	2.93	2.62	2.76	2.46	2.58	2.23	2.34	2.07	2.18	1.89	1.98
	3/8	3.13	3.29	2.94	3.09	2.75	2.89	2.49	2.62	2.31	2.43	2.10	2.21
	1/2	3.47	3.65	3.26	3.43	3.05	3.20	2.75	2.89	2.55	2.68	2.31	2.43
	5/8	3.82	4.02	3.58	3.76	3.34	3.51	3.01	3.16	2.79	2.93	2.53	2.66
	3/4	4.16	4.38	3.90	4.10	3.63	3.82	3.27	3.44	3.03	3.18	2.74	2.88
	7/8	4.51	4.74	4.21	4.43	3.92	4.13	3.53	3.71	3.26	3.43	2.96	3.10
2		4.85	5.10	4.53	4.76	4.22	4.44	3.80	3.98	3.50	3.68	3.17	3.33
	1/4	5.54	5.82	5.17	5.43	4.8	5.05	4.31	4.53	3.98	4.18	3.60	3.78
	1/2	6.23	6.55	5.80	6.10	5.39	5.67	4.83	5.08	4.46	4.69	4.03	4.23
	3/4	6.92	7.27	6.44	6.77	5.98	6.29	5.35	5.63	4.93	5.19	4.46	4.68
3		7.61	8.00	7.08	7.44	6.57	6.91	5.87	6.17	5.41	5.69	4.88	5.13
	1/4	8.29	8.72	7.71	8.11	7.16	7.52	6.39	6.72	5.89	6.19	5.31	5.58
	1/2	8.98	9.44	8.35	8.78	7.74	8.14	6.91	7.27	6.37	6.69	5.74	6.03
	3/4	9.67	10.2	8.98	9.45	8.33	8.76	7.43	7.82	6.84	7.20	6.17	6.48
4		10.4	10.9	9.62	10.1	8.92	9.38	7.96	8.36	7.32	7.70	6.60	6.93
	1/4	11.0	11.6	10.3	10.8	9.50	9.99	8.48	8.91	7.80	8.20	7.02	7.38
	1/2	11.7	12.3	10.9	11.4	10.1	10.6	9.00	9.46	8.28	8.70	7.45	7.84
	3/4	12.4	13.1	11.5	12.1	10.7	11.2	9.52	10.0	8.75	9.20	7.88	8.29
5		13.1	13.8	12.2	12.8	11.3	11.8	10.0	10.5	9.23	9.70	8.31	8.74
	1/4	13.8	14.5	12.8	13.5	11.8	12.5	10.6	11.1	9.71	10.2	8.74	9.19
	1/2	14.5	15.2	13.4	14.1	12.4	13.1	11.1	11.6	10.2	10.7	9.16	9.64
	3/4	15.2	16.0	14.1	14.8	13.0	13.7	11.6	12.2	10.7	11.2	9.59	10.1
6		15.9	16.7	14.7	15.5	13.6	14.3	12.1	12.7	11.1	11.7	10.0	10.5
	1/4	16.5	17.4	15.3	16.1	14.2	14.9	12.6	13.3	11.6	12.2	10.4	11.0
	1/2	17.2	18.1	16.0	16.8	14.8	15.5	13.2	13.8	12.1	12.7	10.9	11.4
	3/4	17.9	18.8	16.6	17.5	15.4	16.2	13.7	14.4	12.6	13.2	11.3	11.9
7		18.6	19.6	17.3	18.1	16.0	16.8	14.2	14.9	13.0	13.7	11.7	12.3
	1/4	19.3	20.3	17.9	18.8	16.5	17.4	14.7	15.5	13.5	14.2	12.2	12.8
	1/2	20.0	21.0	18.5	19.5	17.1	18.0	15.2	16.0	14.0	14.7	12.6	13.2
	3/4	20.7	21.7	19.2	20.1	17.7	18.6	15.8	16.6	14.5	15.2	13.0	13.7
8		21.4	22.5	19.8	20.8	18.3	19.2	16.3	17.1	15.0	15.7	13.4	14.1
	1/4	22.1	23.2	20.4	21.5	18.9	19.9	16.8	17.7	15.4	16.2	13.9	14.6
	1/2	22.7	23.9	21.1	22.2	19.5	20.5	17.3	18.2	15.9	16.7	14.3	15.0
	3/4	23.4	24.6	21.7	22.8	20.1	21.1	17.8	18.8	16.4	17.2	14.7	15.5
9		24.1	25.4	22.3	23.5	20.7	21.7	18.4	19.3	16.9	17.7	15.2	15.9
	1/4	24.8	26.1	23.0	24.2	21.2	22.3	18.9	19.9	17.3	18.2	15.6	16.4
	1/2	25.5	26.8	23.6	24.8	21.8	23.0	19.4	20.4	17.8	18.7	16.0	16.8
	3/4	26.2	27.5	24.3	25.5	22.4	23.6	19.9	21.0	18.3	19.2	16.4	17.3
10		26.9	28.3	24.9	26.2	23.0	24.2	20.4	21.5	18.8	19.7	16.9	17.7

* Based on densities of 0.307 and 0.323 pounds per cubic inch for Brass and Copper respectively.

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CHASE

Pounds Per Lineal Foot*

Stubs Gage		10		11		12		13		14		15	
Dec. Equiv.		0.134		0.120		0.109		0.095		0.083		0.072	
Nearest Fraction		9/64		1/8		7/64		3/32		5/64		1/16	
O.D. in In.		Brass	Copper	Brass	Copper	Brass	Copper	Brass	Copper	Brass	Copper	Brass	Copper
	1/8	..	..	..	..	..	..	..	..	..	..	..	..
	1/4	..	..	.181	.190	.178	.187	.170	.179	.160	.169	.148	.155
	3/8	.373	.393	.354	.372	.335	.352	.308	.324	.280	.295	.252	.265
	1/2	.570	.596	.53	.554	.493	.518	.445	.468	.400	.421	.357	.375
	5/8	.761	.800	.701	.740	.651	.684	.583	.613	.520	.547	.461	.484
	3/4	.955	1.00	.875	.920	.808	.850	.720	.757	.641	.673	.565	.594
	7/8	1.15	1.21	1.05	1.10	.966	1.02	.857	.901	.761	.800	.670	.703
1		1.34	1.41	1.22	1.28	1.12	1.18	.995	1.05	.88	.93	.773	.813
	1/8	1.54	1.61	1.39	1.47	1.28	1.35	1.13	1.19	1.00	1.05	.880	.922
	1/4	1.73	1.82	1.57	1.65	1.44	1.51	1.27	1.33	1.12	1.18	.981	1.03
	3/8	1.92	2.02	1.74	1.83	1.60	1.68	1.41	1.48	1.24	1.30	1.09	1.14
	1/2	2.12	2.23	1.92	2.01	1.75	1.84	1.54	1.62	1.36	1.43	1.19	1.25
	5/8	2.31	2.43	2.09	2.20	1.91	2.01	1.68	1.77	1.48	1.56	1.29	1.36
	3/4	2.50	2.63	2.26	2.38	2.07	2.18	1.82	1.91	1.60	1.68	1.40	1.47
	7/8	2.70	2.84	2.44	2.56	2.23	2.34	1.96	2.06	1.72	1.81	1.50	1.58
2		2.89	3.04	2.61	2.74	2.38	2.51	2.09	2.20	1.84	1.94	1.61	1.69
	1/4	3.28	3.45	2.96	3.11	2.70	2.84	2.37	2.49	2.08	2.19	1.81	1.91
	1/2	3.67	3.86	3.30	3.47	3.01	3.17	2.64	2.78	2.32	2.44	2.02	2.13
	3/4	4.06	4.26	3.65	3.84	3.33	3.50	2.92	3.07	2.56	2.69	2.23	2.35
3		4.44	4.67	4.00	4.20	3.65	3.83	3.19	3.36	2.80	2.94	2.44	2.56
	1/4	4.83	5.08	4.35	4.57	3.96	4.16	3.47	3.65	3.04	3.20	2.65	2.78
	1/2	5.22	5.49	4.69	4.93	4.28	4.50	3.74	3.93	3.28	3.45	2.86	3.00
	3/4	5.61	5.89	5.04	5.30	4.59	4.83	4.02	4.22	3.52	3.70	3.06	3.22
4		5.99	6.30	5.39	5.66	4.91	5.16	4.29	4.51	3.76	3.95	3.27	3.44
	1/4	6.38	6.71	5.73	6.03	5.22	5.49	4.57	4.80	4.00	4.21	3.48	3.66
	1/2	6.77	7.12	6.08	6.39	5.54	5.82	4.84	5.09	4.24	4.46	3.69	3.88
	3/4	7.16	7.52	6.43	6.76	5.85	6.15	5.12	5.38	4.48	4.71	3.90	4.10
5		7.54	7.93	6.77	7.12	6.17	6.48	5.39	5.67	4.72	4.96	4.10	4.32
	1/4	7.93	8.34	7.12	7.49	6.48	6.82	5.66	5.96	4.96	5.22	4.31	4.53
	1/2	8.32	8.75	7.47	7.85	6.80	7.15	5.94	6.25	5.20	5.47	4.52	4.75
	3/4	8.71	9.15	7.82	8.22	7.11	7.48	6.22	6.53	5.44	5.72	4.73	4.97
6		9.09	9.56	8.16	8.58	7.43	7.81	6.49	6.82	5.68	5.97	4.94	5.19
	1/4	9.48	9.97	8.51	8.95	7.74	8.14	6.76	7.11	5.92	6.23	5.15	5.41
	1/2	9.87	10.4	8.86	9.31	8.06	8.47	7.04	7.40	6.16	6.48	5.35	5.63
	3/4	10.3	10.8	9.20	9.68	8.37	8.81	7.31	7.69	6.40	6.73	5.56	5.85
7		10.6	11.2	9.55	10.0	8.69	9.14	7.59	7.98	6.64	6.98	5.77	6.07
	1/4	11.0	11.6	9.90	10.4	9.01	9.47	7.86	8.27	6.88	7.24	5.98	6.29
	1/2	11.4	12.0	10.2	10.8	9.32	9.80	8.14	8.56	7.12	7.49	6.19	6.51
	3/4	11.8	12.4	10.6	11.1	9.64	10.1	8.41	8.85	7.36	7.74	6.40	6.72
8		12.2	12.8	10.9	11.5	9.95	10.5	8.69	9.14	7.60	7.99	6.60	6.94
	1/4	12.6	13.2	11.3	11.9	10.3	10.8	8.96	9.42	7.84	8.25	6.81	7.16
	1/2	13.0	13.6	11.6	12.2	10.6	11.1	9.24	9.71	8.08	8.50	7.02	7.38
	3/4	13.4	14.0	12.0	12.6	10.9	11.5	9.51	10.0	8.32	8.75	7.23	7.60
9		13.7	14.4	12.3	13.0	11.2	11.8	9.79	10.3	8.56	9.00	7.44	7.82
	1/4	14.1	14.9	12.7	13.3	11.5	12.1	10.1	10.6	..	..	..	..
	1/2	14.5	15.3	13.0	13.7	11.8	12.4	10.3	10.9	..	..	..	..
	3/4	14.9	15.7	13.4	14.1	12.2	12.8	10.6	11.2	..	..	..	..
10		15.3	16.1	13.7	14.4	12.5	13.1	10.9	11.4	..	..	..	..

* Based on densities of 0.307 and 0.323 pounds per cubic inch for Brass and Copper respectively.

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Pounds Per Lineal Foot*

Stubs Gage		16		17		18		19		20		21	
Dec. Equiv.		0.065		0.058		0.049		0.042		0.035		0.032	
Nearest Fraction		1/16		3/64		3/64		3/64		1/32		1/32	
O.D. in In.		Brass	Copper	Brass	Copper	Brass	Copper	Brass	Copper	Brass	Copper	Brass	Copper
	1/8	..	..	.045	.048	.043	.045	.040	.042	.036	.038	.034	.036
	1/4	.139	.146	.129	.135	.114	.120	.101	.106	.087	.092	.081	.085
	3/8	.233	.245	.213	.224	.185	.194	.162	.170	.138	.145	.127	.134
	1/2	.327	.344	.297	.312	.256	.269	.223	.234	.188	.198	.173	.182
	5/8	.421	.443	.380	.400	.327	.343	.283	.298	.239	.251	.220	.231
	3/4	.515	.542	.464	.488	.397	.418	.344	.362	.290	.304	.266	.280
	7/8	.609	.640	.548	.576	.468	.492	.405	.426	.340	.358	.312	.328
1		.703	.736	.632	.665	.539	.567	.466	.489	.391	.411	.358	.377
	1/8	.797	.838	.716	.753	.610	.641	.526	.553	.441	.464	.404	.425
	1/4	.891	.937	.800	.841	.681	.716	.587	.617	.492	.517	.451	.474
	3/8	.985	1.04	.884	.929	.752	.790	.648	.681	.543	.570	.497	.523
	1/2	1.08	1.13	.968	1.02	.823	.865	.708	.745	.593	.624	.544	.571
	5/8	1.17	1.23	1.05	1.11	.893	.939	.769	.809	.644	.677	.590	.620
	3/4	1.27	1.33	1.13	1.19	.964	1.01	.830	.873	.694	.730	.636	.669
	7/8	1.36	1.43	1.22	1.28	1.03	1.09	.891	.937	.745	.783	.682	.717
2		1.45	1.53	1.30	1.37	1.11	1.16	.951	1.00	.796	.837	.729	.766
	1/4	1.64	1.73	1.47	1.55	1.25	1.31	1.07	1.13	.897	.943	.821	.863
	1/2	1.83	1.92	1.64	1.72	1.39	1.46	1.19	1.26	.998	1.05	.914	.961
	3/4	2.02	2.12	1.81	1.90	1.53	1.61	1.32	1.38	1.10	1.16	1.01	1.06
3		2.21	2.32	1.97	2.08	1.67	1.76	1.44	1.51	1.20	1.26	1.10	1.15
	1/4	2.39	2.52	2.14	2.25	1.81	1.91	1.56	1.64	1.30	1.37	1.19	1.25
	1/2	2.58	2.72	2.31	2.43	1.96	2.06	1.68	1.77	1.40	1.47	1.28	1.35
	3/4	2.77	2.91	2.48	2.60	2.10	2.21	1.80	1.89	1.50	1.58	1.38	1.45
4		2.96	3.11	2.64	2.78	2.24	2.35	1.92	2.02	1.61	1.69	1.47	1.54
	1/4	3.15	3.31	2.81	2.96	2.38	2.50	2.04	2.15	1.71	1.79	1.56	1.64
	1/2	3.33	3.51	2.98	3.13	2.52	2.65	2.17	2.28	1.81	1.90	1.65	1.74
	3/4	3.52	3.70	3.15	3.31	2.66	2.80	2.28	2.40	1.91	2.01	1.75	1.84
5		3.71	3.90	3.32	3.49	2.81	2.95	2.41	2.53	2.01	2.11	1.84	1.93
	1/4	3.90	4.10	3.48	3.66	2.95	3.10	2.53	2.66	2.11	2.22	1.93	2.03
	1/2	4.09	4.30	3.65	3.84	3.09	3.25	2.65	2.79	2.21	2.33	2.02	2.13
	3/4	4.27	4.49	3.82	4.02	3.23	3.40	2.77	2.92	2.31	2.43	..	..
6		4.46	4.69	3.99	4.19	3.37	3.55	2.89	3.04	2.42	2.54	..	..
	1/4	4.65	4.89	4.15	4.37	3.52	3.70	3.02	3.17	..	..	..	..
	1/2	4.84	5.09	4.32	4.54	3.66	3.84	3.14	3.30	..	..	..	..
	3/4	5.03	5.29	4.49	4.72	3.80	3.99	3.26	3.43	..	..	..	..
7		5.21	5.48	4.66	4.90	3.94	4.14	3.38	3.55	..	..	..	..
	1/4	5.40	5.68	4.83	5.07	4.08	4.29	..	..	..	..	..	..
	1/2	5.59	5.88	4.99	5.25	..	..	..	..	..	..	..	..
	3/4	5.78	6.08	5.16	5.43	..	..	..	..	..	..	..	..
8		5.97	6.27	..	..	..	..	..	..	..	..	..	..
	1/4	6.16	6.47	..	..	..	..	..	..	..	..	..	..
	1/2	6.34	6.67	..	..	..	..	..	..	..	..	..	..
	3/4	6.53	6.87	..	..	..	..	..	..	..	..	..	..
9		6.72	7.06	..	..	..	..	..	..	..	..	..	..
	1/4	..	..	..	..	..	..	..	..	..	..	..	..
	1/2	..	..	..	..	..	..	..	..	..	..	..	..
	3/4	..	..	..	..	..	..	..	..	..	..	..	..
10		..	..	..	..	..	..	..	..	..	..	..	..

* Based on densities of 0.307 and 0.323 pounds per cubic inch for Brass and Copper respectively.

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WEIGHTS OF BRASS AND COPPER TUBE

Pounds Per Lineal Foot*

Stubs Gage		22		23		24		25		26		27	
Dec. Equiv.		0.028		0.025		0.022		0.020		0.018		0.016	
Nearest Fraction		1/32		1/32		1/64		1/64		1/64		1/64	
O.D. in In.		Brass	Copper	Brass	Copper	Brass	Copper	Brass	Copper	Brass	Copper	Brass	Copper
	1/8	.031	.033	.029	.030	.026	.028	.024	.026	.022	.023	.020	.021
	1/4	.072	.076	.065	.068	.058	.061	.053	.056	.048	.051	.043	.046
	3/8	.112	.118	.101	.106	.090	.094	.082	.086	.074	.078	.066	.070
	1/2	.153	.161	.137	.144	.122	.128	.111	.117	.100	.106	.090	.094
	5/8	.193	.203	.174	.182	.153	.161	.140	.147	.126	.133	.113	.118
	3/4	.234	.246	.210	.220	.185	.195	.169	.178	.152	.160	.136	.143
	7/8	.274	.289	.246	.259	.217	.228	.198	.208	.178	.187	.159	.167
1		.315	.331	.282	.297	.249	.262	.227	.238	.204	.215	.182	.192
	1/8	.355	.374	.318	.335	.281	.295	.256	.269	.231	.242	.205	.216
	1/4	.396	.416	.354	.373	.313	.329	.285	.299	.257	.270	.228	.240
	3/8	.436	.459	.390	.410	.344	.362	.313	.330	.282	.297	.252	.264
	1/2	.477	.501	.427	.449	.376	.396	.342	.360	.309	.324	.275	.289
	5/8	.517	.544	.463	.487	.408	.429	.372	.391	.335	.352	..	..
	3/4	.558	.587	.499	.525	.440	.462	.400	.421	.361	.379	..	..
	7/8	.598	.629	.535	.563	.472	.496	.429	.451	.387	.407	..	..
2		.639	.672	.571	.601	.503	.529	.458	.482	.413	.434	..	..
	1/4	.720	.757	.644	.677	.567	.596	.516	.543	..	..	..	..
	1/2	.801	.842	.716	.753	.631	.663	.574	.603	..	..	..	..
	3/4	.882	.927	.788	.829	..	..	..	..	..	..	..	..
3		.963	1.01	.861	.905	..	..	..	..	..	..	..	..
	1/4	1.04	1.10	.933	.981	..	..	..	..	..	..	..	..
	1/2	1.12	1.18	1.00	1.06	..	..	..	..	..	..	..	..
	3/4	1.21	1.27	1.08	1.13	..	..	..	..	..	..	..	..
4		1.29	1.35	..	..	..	..	..	..	..	..	..	..
	1/4	1.37	1.44	..	..	..	..	..	..	..	..	..	..
	1/2	1.45	1.52	..	..	..	..	..	..	..	..	..	..
	3/4	..	..	..	..	..	..	..	..	..	..	..	..

* Based on densities of 0.307 and 0.323 pounds per cubic inch for Brass and Copper respectively.

STANDARD PIPE SIZES

Pounds Per Lineal Foot*

Standard Pipe Size	Outside Diam.	REGULAR					EXTRA HEAVY				
		Inside Diam.	Wall	Brass	Red Brass	Copper	Inside Diam.	Wall	Brass	Red Brass	Copper
⅛"	.405	.281	.062	.246	.253	.259	.205	.100	.353	.363	.371
¼"	.540	.375	.0825	.437	.450	.460	.294	.123	.593	.611	.624
⅜"	.675	.494	.0905	.612	.630	.643	.421	.127	.805	.829	.847
½"	.840	.625	.1075	.911	.938	.957	.542	.149	1.19	1.23	1.25
¾"	1.050	.822	.1140	1.24	1.27	1.30	.736	.157	1.62	1.67	1.71
1"	1.315	1.062	.1265	1.74	1.79	1.83	.951	.182	2.39	2.46	2.51
1¼"	1.660	1.368	.1460	2.56	2.63	2.69	1.272	.194	3.30	3.39	3.46
1½"	1.900	1.600	.1500	3.04	3.13	3.20	1.494	.203	3.99	4.10	4.19
2"	2.375	2.062	.1565	4.02	4.14	4.23	1.933	.221	5.51	5.67	5.79
2½"	2.875	2.500	.1875	5.83	6.00	6.14	2.315	.280	8.41	8.66	8.84
3"	3.500	3.062	.2190	8.31	8.56	8.75	2.892	.304	11.24	11.57	11.82
3½"	4.000	3.500	.2500	10.85	11.17	11.41	3.358	.321	13.67	14.07	14.37
4"	4.500	4.000	.2500	12.29	12.66	12.94	3.818	.341	16.41	16.89	17.25
4½"	5.000	4.500	.2500	13.74	14.15	14.46	4.250	.375	20.07	20.66	21.10
5"	5.563	5.062	.2505	15.40	15.85	16.21	4.813	.375	23.67	23.18	23.69
6"	6.625	6.125	.2500	18.44	18.99	19.41	5.750	.437	31.32	32.21	32.93
7"	7.625	7.062	.2815	23.92	24.63	25.17	6.625	.500	41.23	42.43	43.34
8"	8.625	8.000	.3125	30.05	30.95	31.63	7.625	.500	47.02	48.39	49.42
9"	9.625	8.937	.3440	36.94	38.03	38.83	8.625	.500	52.81	54.34	55.56
10"	10.750	10.019	.3655	43.91	45.20	46.22	9.750	.500	59.32	61.05	62.40
11"	11.750	11.000	.3750	49.37	50.81	51.94	..	..	..	..	..
12"	12.750	12.000	.3750	53.71	55.29	56.51	..	..	..	..	..

* Based on densities of 0.307, 0.316, and 0.323 pounds per cubic inch for Brass, Red Brass, and Copper respectively.

COPPER WATER TUBE FOR COMPRESSION OR SOLDERED FITTINGS

Standard Dimensions, Weights, and Diameter and Wall Thickness Tolerances

(All Tolerances Plus and Minus)

Nominal Size	Actual Outside Diameter in Inches	Permissible Variations in Mean Outside Diameters in Inches		WALL THICKNESS—IN INCHES								WEIGHT PER FOOT, POUNDS			
				Class K		Class L		Class M		Class O					
		Annealed	Hard Drawn	Nominal	Permissible Variation	Nominal	Permissible Variation	Nominal	Permissible Variation	Nominal	Permissible Variation	Class K	Class L	Class M	Class O
1/8	.250	.002	.001	.032	.003	.025	.003	.025	.003			0.085	0.068		
1/4	.375	.002	.001	.032	.004	.030	.0035	.025	.0025			0.133	0.126	0.106	
3/8	.500	.0025	.001	.049	.004	.035	.0035	.025	.0025			0.269	0.198	0.144	
1/2	.625	.0025	.001	.049	.004	.040	.0035	.028	.0025			0.344	0.285	0.203	
*3/4	.875	.003	.001	.065	.0045	.045	.004	.032	.003			0.641	0.455	0.328	
1	1.125	.0035	.0015	.065	.0045	.050	.004	.035	.0035			0.839	0.655	0.464	
1¼	1 375	.004	.0015	.065	.0045	.055	.0045	.042	.0035			1.04	0.884	0.681	
1½	1.625	.0045	.002	.072	.005	.060	.0045	.049	.004			1.36	1.14	0.94	
2	2.125	.005	.002	.083	.005	.070	.005	.058	.0045			2.06	1.75	1.46	
2½	2.625	.005	.002	.095	.005	.080	.005	.065	.0045			2.92	2.48	2.03	
3	3.125	.005	.002	.109	.005	.090	.005	.072	.0045	.049	.004	4.00	3.33	2.68	1.83
3½	3.625	.005	.002	.120	.005	.100	.005	.083	.005	.049	.004	5.12	4.29	3.58	2.13
4	4.125	.005	.002	.134	.006	.110	.005	.095	.005	.058	.004	6.51	5.38	4.66	2.87
5	5.125	.005	.002	.160	.006	.125	.006	.109	.005	.065	.005	9.67	7.61	6.66	4.00
6	6.125	.005	.002	.192	.008	.140	.006	.122	.005	.072	.005	13.87	10.20	8.91	5.31
8	8.125	.006	.003	.271	.010	.200	.008	.170	.006	.083	.005	25.9	19.29	16.46	8.12
10	10.125	.008	.004	.338	.012	.250	.010	.212	.007	.109	.006	40.26	30.04	25.57	13.28
12	12.125	.008	.004	.405	.014	.280	.012	.254	.008	.134	.007	57.76	40.36	36.69	19.55
*5/8	.750	.0025	.001	.049	.004	.042	.0035					0.418	0.362		

LENGTH:

(a) The nominal length for tubes furnished straight shall be 20 ft.
(b) The nominal lengths for tubes furnished in coils shall be 30, 45 and 60 ft.

PERMISSIBLE VARIATIONS:

(a) No combination of variations on the same tube shall make the thickness of the wall vary from the nominal thickness by more than the amount specified in Table II.
(b) No single tube shall vary in weight by more than 5 per cent from the theoretical weight per foot values given in Table II.
(c) Tubes shall not be less than the nominal length.

GAGE

Gauge No.	Inches	Up to 8" wide inc.	Over 8" to 14" wide inc.	Over 14" to 20" wide inc.
0000	.4600	.0046	.0050	.0055
000	.4096	.0044	.0048	.0053
00	.3648	.0043	.0047	.0051
0	.3249	.0042	.0045	.0049
1	.2893	.0040	.0043	.0048
2	.2576	.0039	.0042	.0046
3	.2294	.0038	.0041	.0045
4	.2043	.0037	.0039	.0043
5	.1819	.0035	.0038	.0042
6	.1620	.0034	.0037	.0041
7	.1443	.0033	.0035	.0039
8	.1285	.0032	.0034	.0038
9	.1144	.0030	.0033	.0037
10	.1019	.0029	.0032	.0035
11	.0907	.0028	.0030	.0034
12	.0808	.0027	.0029	.0033
13	.0720	.0025	.0028	.0032
14	.0641	.0024	.0027	.0030
15	.0571	.0023	.0026	.0029
16	.0508	.0022	.0025	.0028
17	.0453	.0021	.0024	.0027
18	.0403	.0020	.0023	.0026
19	.0359	.0018	.0022	.0025
20	.0320	.0017	.0021	.0024
21	.0285	.0016	.0020	.0023
22	.0254	.0015	.0019	.0022
23	.0226	.0014	.0018	.0021
24	.0201	.0013	.0017	.0020
25	.0179	.0012	.0016	.0019
26	.0159	.0011	.0016	.0019
27	.0142	.0010	.0015	.0018
28	.0126	.0009	.0014	.0017
29	.0113	.0008	.0013	.0016
30	.0100	.0007	.0012	.0015
31	.0089	.0006	.0012	.0015
32	.0080	.0006	.0011	.0014
33	.0071	.0005	.0010	.0013
34	.0063	.0005	.0009	.0013
35	.0056	.0004	.0009	.0012
36	.0050	.0004	.0008	.0011
37	.0045	.0004	.0008	.0011
38	.0040	.0003	.0007	.0010

All tolerances plus and minus; should be doubled to obtain total variation.

25% extra for Nickel Silver, Phosphor Bronze, Cold Rolled Muntz Metal, Aluminum Bronze, Silicon Bronze, Manganese Bronze, Beryllium Copper and other refractory alloys.

"Refractory alloys" are defined as those containing in excess of ½% Tin; ½% Silicon; 5% Nickel; 2% Aluminum.

TOLERANCES FOR SHEET AND STRIP

WIDTH—All plus and minus

14 and over	Over .064	.012	.014	.017
Under 14 to 20 inc.	Under .064 to .032 inc.	.010	.012	.014
Under 20 to 32 inc.	Under .032 to .0079 inc.	.012	.014	.017
Under 32	Under .0079	.014	.017	.020

LENGTH

On all sizes cut to specified exact length, plus or minus 1/8″.

TOLERANCES FOR ROD

All Plus or Minus

Diameter or Distance Across Flats	Drawn Finish		Extruded Finish	
	Rounds	Other Shapes	Rounds	Other Shapes
Up to 1/2″ inc.	0.0015	0.003		0.005″
Over 1/2″ to 1″ inc.	0.002	0.004	0.008	1.0%
Over 1″ to 2 1/2″ inc.	0.0025	0.005	0.012	1.0%
Over 2 1/2″	0.15%	0.30%	0.60%	1.0%

TOLERANCES FOR WIRE

Diameter	Tolerance
Up to .040″ inc.	0.00025
Over .040″ to .075″ inc.	0.0005
Over .075″ to .140″ inc.	0.00075
Over .140″ to .250″ inc.	0.001
Over .250″ to .500″ inc.	0.0015

NOTE: If any tolerance is desired all plus or all minus instead of plus and minus, twice the figure given above should be used.

Wall Thickness and Weight Tolerances—All Plus or Minus

		Up to 2" Dia.			Over 2" to 4" Dia.			Over 4" to 7" Dia.			Over 7" to 10" Dia.		
Stubs Gage No.	Gage in Inches	Gage	Weight Lots 1-10 Pcs.	Weight Lots Over 10 Pcs.	Gage	Weight Lots 1-10 Pcs.	Weight Lots Over 10 Pcs.	Gage	Weight Lots 1-10 Pcs.	Weight Lots Over 10 Pcs.	Gage	Weight Lots 1-10 Pcs.	Weight Lots Over 10 Pcs.
Over 2-0	Over .380	5%	2.5%	1.5%	5%	2.5%	1.5%	6%	3%	1.5%	6%	4%	2%
Under 2-0 to 2 inc.	.379 to .284 inc.	.012"	2.5%	1.5%	.014"	3%	1.5%	.016"	4%	2%	.018"	5%	2.5%
Under 2 to 5 inc.	.283 to .220 inc.	.010"	3%	1.5%	.012"	3.5%	2%	.014"	5%	2.5%	.016"	6%	2.5%
Under 5 to 8 inc.	.219 to .165 inc.	.008"	3.5%	2%	.010"	4%	2%	.012"	6%	2.5%	.014"	7%	3%
Under 8 to 11 inc.	.164 to .120 inc.	.006"	4%	2%	.008"	5%	2.5%	.010"	7%	3%	.012"	8%	3%
Under 11 to 14 inc.	.119 to .083 inc.	.005"	5%	2.5%	.007"	6%	2.5%	.009"	8%	3%	.011"	9%	3.5%
Under 14 to 17 inc.	.082 to .058 inc.	.004"	6%	2.5%	.006"	7%	3%	.008"	9%	3.5%	.010"	10%	3.5%
Under 17 to 20 inc.	.057 to .035 inc.	.003"	7%	3%	.005"	8%	3%	.007"	10%	3.5%			
Under 20 to 23 inc.	.034 to .025 inc.	.0025"	8%	3%	.004"	9%	3.5%						
Under 23	Under .025	.0025"	9%	3.5%									

DIAMETER TOLERANCE—ALL PLUS OR MINUS

	Up to 1"	Over 1" to 2" inc.	Over 2" to 3" inc.	Over 3" to 4" inc.	Over 4" to 5" inc.	Over 5" to 6" inc.	Over 6" to 8" inc.	Over 8" to 10" inc.
Diameter Tolerance	.0025"	.003"	.004"	.005"	.006"	.007"	.008"	.010"

LENGTH TOLERANCE—ALL PLUS OR MINUS

Up to 1 ft.	1/64"
Over 1 ft. to 10 ft.	1/32"
Over 10 ft.	1/16"

NOTE 1—All tolerances listed are given as plus or minus. If any tolerance is desired all plus or all minus instead of plus and minus, twice the figure given should be used.

NOTE 2—The wall thickness given is interpreted as maximum variation from the nominal at any point.

NOTE 3—The weight tolerance given is interpreted as the percentage variation from the calculated weight.

NOTE 4—The diameter tolerance given is interpreted as variation in the mean diameter and does not take into account lack of roundness. Further, this diameter tolerance may be applied to either the inside diameter or the outside diameter, but not to both on the same tubing (e. g., when the above tolerance is applied to the outside diameter it will be found that the inside diameter will be affected by the wall thickness tolerance as well as the outside diameter tolerance).

COMPARISON OF GAGE SYSTEMS

Gage No.	American or Brown & Sharpe	Birmingham or Stubs	Was'n and Moen	Imperial S. W. G.	London or Old English	United States Standard
0000000	..	..	.490	.500	..	.500
000000	.580	..	.462	.464	..	.469
00000	.517	..	.431	.432	..	.438
0000	.460	.454	.394	.400	.454	.406
000	.410	.425	.363	.372	.425	.375
00	.365	.380	.331	.348	.380	.344
0	.325	.340	.307	.324	.340	.313
1	.289	.300	.283	.300	.300	.281
2	.258	.284	.263	.276	.284	.266
3	.229	.259	.244	.252	.259	.250
4	.204	.238	.225	.232	.238	.234
5	.182	.220	.207	.212	.220	.219
6	.162	.203	.192	.192	.203	.203
7	.144	.180	.177	.176	.180	.188
8	.129	.165	.162	.160	.165	.172
9	.114	.148	.148	.144	.148	.156
10	.102	.134	.135	.128	.134	.141
11	.091	.120	.121	.116	.120	.125
12	.081	.109	.106	.104	.109	.109
13	.072	.095	.092	.092	.095	.094
14	.064	.083	.080	.080	.083	.078
15	.057	.072	.072	.072	.072	.073
16	.051	.065	.0625	.064	.065	.0625
17	.045	.058	.0540	.056	.058	.0563
18	.0403	.049	.0475	.048	.049	.0500
19	.0359	.042	.0410	.040	.040	.0438
20	.0320	.035	.0348	.036	.035	.0375
21	.0285	.032	.0317	.032	.0315	.0344
22	.0254	.028	.0286	.028	.0295	.0313
23	.0226	.025	.0258	.024	.0270	.0281
24	.0201	.022	.0230	.022	.0250	.0250
25	.0179	.020	.0204	.020	.0230	.0219
26	.0159	.018	.0181	.018	.0205	.0188
27	.0142	.016	.0173	.0164	.0188	.0172
28	.0126	.014	.0162	.0148	.0165	.0156
29	.0113	.013	.0150	.0136	.0155	.0141
30	.0100	.012	.0140	.0124	.0138	.0125
31	.0089	.010	.0132	.0116	.0123	.0109
32	.0080	.009	.0128	.0108	.0113	.0102
33	.0071	.008	.0118	.0100	.0103	.0094
34	.0063	.007	.0104	.0092	.0095	.0086
35	.0056	.005	.0095	.0084	.0090	.0078
36	.0050	.004	.0090	.0076	.0075	.0070
37	.0045	..	.0085	.0068	.0065	.0066
38	.0040	..	.0080	.0060	.0058	.0063
39	.0035	..	.0075	.0052	.0050	..
40	.0031	..	.0070	.0048	.0045	..

Decimal Equiv.	Fractions				Decimal Equiv.	Fractions			
.0156	1/64	....	....	....	.5156	33/64	....	....	....
.0312	....	1/32	....	....	.5312	....	17/32	....	....
.0469	3/64	....	....	....	.5469	35/64	....	....	....
.0625	....	....	1/16	....	.5625	....	....	9/16	....
.0781	5/64	....	....	....	.5781	37/64	....	....	....
.0937	....	3/32	....	....	.5937	....	19/32	....	....
.1094	7/64	....	....	....	.6094	39/64	....	....	....
.1250	....	....	....	1/8	.6250	....	....	....	5/8
.1406	9/64	....	....	....	.6406	41/64	....	....	....
.1562	....	5/32	....	....	.6562	....	21/32	....	....
.1719	11/64	....	....	....	.6719	43/64	....	....	....
.1875	....	....	3/16	....	.6875	....	....	11/16	....
.2031	13/64	....	....	....	.7031	45/64	....	....	....
.2187	....	7/32	....	....	.7187	....	23/32	....	....
.2344	15/64	....	....	....	.7344	47/64	....	....	....
.2500	....	....	....	1/4	.7500	....	....	....	3/4
.2656	17/64	....	....	....	.7656	49/64	....	....	....
.2812	....	9/32	....	....	.7812	....	25/32	....	....
.2969	19/64	....	....	....	.7969	51/64	....	....	....
.3125	....	....	5/16	....	.8125	....	....	13/16	....
.3281	21/64	....	....	....	.8281	53/64	....	....	....
.3437	....	11/32	....	....	.8437	....	27/32	....	....
.3594	23/64	....	....	....	.8594	55/64	....	....	....
.3750	....	....	....	3/8	.8750	....	....	....	7/8
.3906	25/64	....	....	....	.8906	57/64	....	....	....
.4062	....	13/32	....	....	.9062	....	29/32	....	....
.4219	27/64	....	....	....	.9219	59/64	....	....	....
.4375	....	....	7/16	....	.9375	....	....	15/16	....
.4531	29/64	....	....	....	.9531	61/64	....	....	....
.4687	....	15/32	....	....	.9687	....	31/32	....	....
.4844	31/64	....	....	....	.9844	63/64	....	....	....
.5000	....	....	....	1/2	1.0000	....	....	....	1

Chase Brass & Copper Co. operates 18 warehouses in principal cities throughout the country. Each warehouse carries a large stock of Brass, Copper and Bronze in various forms.

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